The Great Basin Naturalist

VOLUME XX. 1960

Editor: Vasco M. Tanner
Assistant Editor: Stephen L. Wood
Assistant Editor: Wilmer W. Tanner

Published at Provo, Utah by
Brigham Young University

TABLE OF CONTENTS

Volume XX

Nos. 1 and 2 August 25, 1960

Nos. 3 and 4 November 30, 1960

The Great Basin NATURALIST

VOLUME XX August 25, 1960 Nos. 1 and 2

TABLE OF CONTENTS

PUBLISHED BY
BRIGHAM YOUNG UNIVERSITY

The Great Basin Naturalist

A journal published fron one to four times a year by Brigham Young University, Provo, Utah

MANUSCRIPTS: Only original unpublished manuscripts, pertaining to the Great Basin and the Western United States in the main, will be accepted. Manuscripts are subject to the approval of the editor.

ILLUSTRATIONS: All illustrations should be made with a view to having them appear within the limits of the printed page. The illustrations that form a part of an article should accompany the manuscript. All half-tones or zinc etchings to appear in this journal are to be made under the supervision of the editor, and the cost of the cuts is to be borne by the contributor.

REPRINTS: No reprints are furnished free of charge. A price list for reprints and an order form is sent with the proof.

SUBSCRIPTIONS: The annual subscription is $2.50, (outside the United States $3.25). Single number, 80 cents.

All correspondence dealing with manuscripts, subscriptions, reprints and other business matters should be addressed to the Editor, Vasco M. Tanner, Great Basin Naturalist, Brigham Young University, Provo, Utah.

REPRINTS SCHEDULE OF THE GREAT BASIN NATURALIST

	2 pp.	4 pp.	6 pp.	8 pp.	10 pp.	12 pp.	Each Additional 2 pp.
50 copies	$5.00	$6.00	$7.00	$8.00	$9.00	$10.00	$1.50
100 copies	6.00	7.00	8.00	9.00	10.00	11.00	
200 copies	7.00	8.00	9.00	10.00	11.00	12.00	
300 copies	8.00	9.00	10.00	11.00	12.00	13.00	

COVERS: $8.00 for first 100 copies; $3.00 for additional 100 copies.

The Great Basin Naturalist

Published at Provo, Utah by
Brigham Young University

Volume XX August 25, 1960 Nos. 1 & 2

THE FEMALE GENITALIA AND SPERMATHECAE OF SOME OF THE RHYNCHOPHORA

Herman O. Sanders[1]

INTRODUCTION

The Rhynchophora or weevils consist of a large group or series of beetles popularly known as "snout" beetles. They are world-wide in their distribution and fall into eight or nine well defined groups.

To this large assemblage are added many new species each year, and at the present time it is difficult to positively identify some of the early described species because their original descriptions have been made from variable external features. Since 1900 there has been a decided improvement in systematic work and the taxonomist is beginning to use internal morpohlogical and physiological characters in combination with external taxonomic features in the description of new species. There will be a vast improvement in our present day classification and a better understanding of the phylogenetic relationship when all available characters are used in taxonomic work.

Although this study does not include all the sub-family divisions of the group, because of their rarity, it does include a majority of the divisions of the Rhynchophora occurring in North America.

The external genitalia and spermatheca of the female are useful in taxonomic work, although their importance is frequently no greater and sometimes less than that of other structural characters. The principal objections to the use of the spermatheca in taxonomic work is that they are not available for interpretation without mutilating the specimens; they are of value only when a series of specimens are available; and because of the small size of some insects, they are not easy to observe.

While making this study two objectives have been kept in mind:

First, to determine the differences occurring in the spermatheca of different species and to find if these differences are significant enough to warrant their future use in classification.

Second, to determine the differences that exist in the external

1 Editor's Note. Mr. Sanders submitted this paper as a thesis to the Department of Zoology and Entomology of Brigham Young University in partial fulfillment of the requirements for the degree of Master of Science. In editing this study some changes and deletions have been made. Contribution No. 171 from the Department of Zoology and Entomology.

genitalia of as many species as possible to establish the phylo genetic relationships that exist in the family and sub-family divisions of the Rhynchophora based on these structures.

ACKNOWLEDGMENTS

This work was carried on under the direction of Dr. Vasco M. Tanner, head of the Department of Zoology and Entomology, Brigham Young University, to whom the writer desires to express appreciation and thanks for his many invaluable suggestions, criticisms, and aid in making the drawings and their arrangement in the plates. I am also greatly indebted to Dr. Tanner and wish to sincerely thank him for providing the insects used in this study.

The writer also wishes to express his thanks to Dr. C. Lynn Hayward, Dr. Wilmer W. Tanner and Dr. D Elden Beck of the department, for their aid and suggestions in the preparation of the manuscript.

SPECIES STUDIED

Eighty-two species of Rhynchophora, representing sixty genera, were examined in this study and are listed as they appear in Leng's Catalogue of Coleoptera of North America. Also included in this study are seven species from the Philippine Islands and one from China.

Family BRENTIDAE
Ectocemus 10-maculatus Montr. P. Islands. Figs. 1 & 2.
Family PLATYSTOMIDAE
Eurymycter fasciatus (Oliv.) Figs. 3 & 4.
Phoenicobiella chamaeropis Lec. Figs. 8 & 9.
Anthribus cornutus Say. Fig. 7.
Euparius marmoreus (Oliv.) Fig. 13.
Euparius lugubris (Oliv.) Figs. 5 & 6.
Araeocerus fasciculatus (DeG.) Fig. 10.
Family BELIDAE
Ithycerus noveboracensis (Forst.) Figs. 24 & 25.
Family CURCULIONIDAE
Sub-family RHINOMACERINAE
Rhinomacer elongatus Lec. Figs. 11 & 12.
Sub-family RHYNCHITINAE
Rhynchites bicolor Fab. Figs. 14 & 15.
Rhynchites aeneus Boh. Fig. 16.
Sub-family ATTELABINAE
Attelabus rhois Boh. Fig. 20.
Attelabus analis Ill. Fig. 19.
Sub-family PTEROCOLINAE
Pterocolus ovatus (Fab.) Figs. 17 & 18.
Sub-family CYLADINAE
Cylas formicarius (Fab.) Fig. 23.
Sub-family APIONINAE
Apion porcatum Boh. Fig. 21.
Apion rostrum Say. Fig. 22.
Sub-family OTIORHYNCHINAE
Eupagoderes nivosus Fall. Fig. 39.

Eupagoderes sordidus (Lec.) Fig. 34.
Eupagoderes argentatus (Lec.) Fig. 40.
Eupagoderes desertus Horn. Fig. 36.
Ophryastes vittatus (Say) Fig. 30.
Ophryastes latirostris Lec. Fig. 31.
Ophryastes sulcirostris (Say) Fig. 33.
Miloderes setosus Csy. Figs. 50 & 51.
Melamomphus alternatus (Horn) Fig. 42.
Dyslobus wasatchensis Tanner. Fig. 41.
Panscopus aequalis (Horn) Figs. 48 & 49.
Pandeleteius hilaris (Hbst.) Fig. 35.
Compsus auricephalus (Say) Figs. 45 & 46.
Cyphus placidus Horn. Figs. 37 & 38.
Polydrusus americanus Gyll. Fog. 58.
Scythropus elegans (Couper) Fig. 52.
Scythropus californicus Horn. Fig. 53.
Hormorus undulatus (Uhler) Figs. 56 & 57.
Epicaerus wickhami Pierce. Figs. 54 & 55.
Pantomorus pallidus (Horn) Fig. 61.
Pantomorus fulleri (Horn) Fig. 62.
Brachyrhinus sulcatus Fab. Fig. 47.
Geoderces imcomptus Horn. Fig. 64.
Episomus lentus Erichs. Luson P. Islands. Figs. 43 & 44.
Apocyrtus inflatus Erichs. Luson, P. Islands. Figs. 27 & 28.
Metapocyrtus profanus Erichs. Luson, P. Islands Fig. 29.
Metapocyrtus chevrolati Waterh. Luson, P. Islands. Fig. 26.
Metapocyrtus gregarius Erichs. Luson, P. Islands. Fig. 32.
Hypomeces squamous Fab. Canton, China. Figs. 59 & 60.

Sub-family CURCULIONINAE

Hypera punctata (Fab.) Fig. 63.
Phytonomus eximius Lec. Figs. 65 & 66.
Phytonomus meles (Fab.) Fig. 68.
Phytonomus nigrirostris (Fab.) Fig. 67.
Phytonomus posticus (Gyll.) Fig. 69.
Lepyrus palustris Scop. Figs. 92 & 93.
Listronotus callosus Lec. Figs. 73 & 74.
Listronotus caudatus (Say) Fig. 75.
Pissodes strobi (Peck) Figs. 78 & 79.
Pissodes affinis Rand. Fig. 82.
Alcides schonherri Jekel. Luson, P. Islands. Figs. 80 & 81.
Pachylobius picivorus (Germ) Fig. 76.
Dorytomus brevisetosus Csy. Fig. 77.
Notaris puncticollis Lec. Fig. 83.
Tychius lineellus Lec. Fig. 72.
Magdalis lecontei Horn. Fig. 84.
Magdalis substriga Fall. Fig. 85.
Magdalis gentilis Lec. Fig. 86.
Balaninus proboscideus (Fab.) Fig. 87.
Balaninus caryae Horn. Fig. 90.
Balaninus rectus Say. Fig. 94.

Balaninus baculi Chitt. Fig. 91.
Balaninus strictus Csy. Fig. 95.
Balaninus victoriensis Chitt. Fig. 96.
Anthonomus scutellaris Lec. Fig. 70.
Anthonomus grandis Boh. Fig. 71.
Dinocleus albovestitus Csy. Fig. 97.
Cleonus calandroides (Rand.) Fig. 98.
Lixus concavus Say. Fig. 99.
Lixus scrobicollis Boh. Fig. 101.
Lixus tarminalis Lec. Fig. 100.
Rhinoncus pyrrhopus Boh. Fig. 89.
Cryptorhynchus parochus (Hbst.) Fig. 88.

Sub-family THECESTERNINAE
Thecesternus humeralis (Say) Figs. 102 & 103.

Sub-family CALENDRINAE
Scyphophorus acupunctatus Gyll. Figs. 105 & 106.
Scyphophorus yuccae Horn. Figs. 107 & 108.
Rhondobaenus tredecimpunctatus (Ill.) Fig. 109.
Calendra ochreus Lec. Fig. 110.
Calendra costipennis (Horn) Figs. 111 & 112.
Calendra parvulus Gyll. Fig. 114.
Calendra destructor Chitt. Fig. 104.
Calendra zear Walsh. Fig. 113.

Family SCOLYTIDAE

Sub- family SCOLYTINAE
Scolytus ventralis Lec. Fig. 115.

Sub-family HYLESININAE
Dendroctonus terebrans (Oliv.) Fig. 116.
Dendroctonus valens Lec. Fig. 117.

TECHNIQUE

The specimens used in making this study were obtained from the Brigham Young University entomological collection. They were first placed in warm water until they were fully relaxed. The abdomen was removed and the genitalia extended with a pair of forceps. The structures were then placed in a weak solution of caustic potash and heated until only the cuticular portions remained.

After the specimens were sufficiently cleared, they were placed in water and washed to remove the excess caustic potash solution. The structures were run through an alcohol series (50%, 70%, 85%, 100%), including xylol and carbo-xylol, for dehydration and clearing the sclerotized structures. The spermatheca was extracted from the abdomen with a pair of hair-spring tweezers. This was not done until the structures were sufficiently cleared and ready for mounting. In this way the structures were not lost during transfer in the dehydration and clearing process. The structures were then mounted on a slide in Canada balsom.

In most cases the external genitalia were mounted to show a ventral view. The spermatheca was mounted on the same slide with the external genitalia in order that a comparison of these two structures could be made in each species or series. Since few drawings

were made before the genitalia were mounted, in general, only a ventral view has been figured. In the tribe Ophryastini the styli are very small and can be seen only from the lateral aspect and in this case a lateral view of the genitalia was studied before the organ was mounted.

The drawings were made by the use of a bioscope, the outlines and principal structures being traced and the details filled in later from under a compound binocular microscope. The spermatheca of all the species sstudied have been drawn, but it is beyond the scope of this study to make drawings of all the external genital structures.

The sclerotized areas in the drawings were represented in two ways, by a solid black area and by unstippled areas. The membranous portions were lightly stippled. In certain species the ramus and nodulus portions of the spermatheca was heavily sclerotized, but to show uniformity this was not included in the drawings. In cases where both of these structures have been figured, the external genitalia precedes the spermatheca.

PREVIOUS WORK

The writer had access to a fairly complete collection of literature concerning the Rhynchophora. A review of the literature showed information concerning the genitalia and spermathecae, especially on the Rhynchophora, to be limited. The use and study of the spermatheca in taxonomy seems to open a new field in which there has been no comprehensive study of this structure.

Some very valuable contributions were made by the early workers in this field but they were greatly handicapped by the methods in use at that time. Since the turn of this century some of the best work has been done because of new morphological methods introduced and the advancement in the use of scientific illustrations.

In 1927 Tanner made a study of the external female genitalia of the order Coleoptera, including three families of the Rhynchophora. He found that certain characters of the genitalia were useful guides in taxonomic work.

In 1931 Dobzhansky made a study of the North American beetles of the genus *Coccinella* (Family Coccinellidae) and found the structure of the external female genitalia to be useful in the determination of species in this genus. Dobzhansky also make a study of the spermathecae and found that they were of value in separating many of the species.

Tanner in 1943 made a study of the Sub-tribe Hydronomi and used the external female genital structures and spermathecae in the description of new species. In this paper the female genital structures were used in separating members of this sub-tribe and were used in generic as well as specific separation of members of this sub-tribe.

The latest paper of value that comes to my attention is, "A Review of the Weevils of the Tribe Ophryastini of America North of Mexico" by Davis, published in 1947. In this study the male and female genital structures were studied and found to be of value in grouping related species and often in distinguishing individual spe-

cies. The spermatheca was dissected out and figured for a few of the species but no mention was made as to its function or morphology. In this study Davis found it very difficult to separate the genera, *Ophryastes* and *Eupagoderes*, because there was no character which would hold throughout the group. He states that while the genitalia vary from one species to another, there seems to be no good genitalic character that applies well enough to them all to give a reliable point upon which to base their separation. It is not known if the spermatheca was studied in the separation of the two genera.

STUDY OF FAMILY AND SUB-FAMILY STRUCTURES

On the basis of the genitalia and spermatheca the specimens examined seem to fall into eight and possibly nine well-defined groups. Since drawings of these structures have been made, only a brief summary of the characteristics will be given for each group.

FAMILY BRENTIDAE

Ectocemus 10-maculatus Montr. Figs. 1 & 2

FAMILY CHARACTERISTICS: The spermatheca is large and lightly sclerotized; cornu short coming to a sharp point, sharply hooked and regular; ducts entering nodulus and ramus portions very close with no pronounced division between the two. The genitalia is heavily sclerotized; coxites large, styli are small and borne on the distal membranous portion. Small baculi present extending from the ninth membranous segment to the coxites. The eighth sternite is greatly modified.

FAMILY PLATYSTOMIDAE
SUB-FAMILY RHINOMACERINAE (CURCULIONIDAE).

CHARACTERISTICS OF THE GROUP: The spermathecae in this group are small and lightly sclerotized; cornu is broad, regular and not hooked; ducts entering the nodulus and ramus portions are very close and in some species almost indistinguishable; no marked division between the nodulus and ramus. The genitalia is lightly sclerotized except for the coxites and baculi; coxites heavily sclerotized and enlarged into a broad tridentate plate on each side; styli are small and borne on the lateral side between the teeth, except in the two species, *Arthribus cornutus* Say and *Rhinomacer elongatus* Les., in which the coxites are not of this form and the styli are much larger and borne on the distal portion of coxites. Baculi present as long heavily sclerotized rods.

Using the spermatheca as a criterion, the sub-family Rhinomacerinae has been included in this family. In most other studies this sub-family has been included in the following group.

FAMILY CURCULIONIDAE

Sub-families: Rhynchitinae, Peterocolinae, Attelabinae.

CHARACTERISTICS OF THE GROUP: The spermatheca is large and lightly sclerotized and regular, except in *Pterocolus ovatus* (Fab.) Figure 18, in which it is very small, slightly sclerotized and crenulate. The cornu is short and broad, not hooked; the ducts leading to

the nodulus and ramus are close with no distinct separation between the two portions. The female genitalia are similar and of the compact type; coxites large and lightly sclerotized; the coxites bear small terminal styli. There are no baculi in any of the species studied in this group, except possibly in the Rhynchitinae where the sclerotized portion of the coxites extend down to the ninth segment. The eighth segment is modified and lightly sclerotized.

SUB-FAMILY CYLADINAE Fig. 23.

CHARACTERISTICS OF THE SUB-FAMILY: The spermatheca is very small and lightly sclerotized; cornu long, thin, regular and only slightly hooked; nodulus rudimentary and ramus is slightly developed and crenulate on the under side and slightly separate from nodulus. The genitalia is of the compact type and very lightly sclerotized; coxites are small with lower half slightly chitinized or membranous; styli are minute and borne on the terminal portion of coxites. The eighth segment is modified and membranous. On the basis of the spermatheca this sub-family has been set off in a separate group. Whether the characteristic used in separating this group from others is distinctive enough is doubtful, but in this study it will be described as a distinct group.

SUB-FAMILY APIONINAE Figs. 21 & 22.

CHARACTERISTICS OF THE SUB-FAMILY: The spermatheca is very small and heavily sclerotized; cornu is long and thin, heavily crenulate and sharply hooked; ducts leading to nodulus and ramus are close with no distinct separation between these two portions. The genitalia is of the compact type and lightly sclerotized; styli are small and borne on the terminal portion of the coxites. The eighth segment is membranous.

FAMILY BELIDAE

Ithycerus noveboracensis (Forst.) Figs. 24 & 25

FAMILY CHARACTERISTICS: The spermotheca is a very remarkable and unusual form. It is a long tube with a rounded head at one end, with the cornu curving sharply upward. A spiral duct enters close to the head and at the same place there is a connection with a rather long tubular gland. The modulus and ramus are highly sclerotized with no pronounced division between the two portions The genitalia is membranous except for the large heavily sclerotized coxites; styli are small and borne on the terminal portion of the coxites; no baculum present.

This is the only species of the genus, and at the same time the only species known of a very distinct sub-family allied to the Australian Belidae. The genitalia and spermatheca of the *Ithycerus* resemble more closely those of the Curculionidae than they do the Platystomidae and Attelabidae.

SUB-FAMILY OTIORHYNCHINAE & CURCULIONINAE

CHARACTERISTICS OF THE TWO SUB-FAMILIES: No sharp line of demarcation exists between the two sub-families as they are listed in Leng's Catalogue. Many differences occur in the length of the cornu, the size of the entire spermatheca, relative development of nodulus and ramus and in the degree of sclerotization. The general type de-

scribed as one group in which there is much variation. This group shows a remarkable development over the previous groups in that the nodulus and ramus are well developed, in most cases, with a pronounced division between these two portions. In certain species of this group the ductus receptaculi becomes distinct, while in others it is very close with the ramus and not developed.

In most cases the nodulus and ramus are heavily chitinized and often crenulate in many of the species. This group contains both the elongate and compact forms of the genitalia, with specimens of the elongate genitalia contining a baculum. In the species *Epicaerus wickhami* Pierce the coxites are almost divided into two segments and are separated in certain of the specimens examined in this group.

SUB-FAMILY CALENDRINAE

CHARACTERISTICS OF THE SUB-FAMILY: The spermatheca is large with the nodulus and ramus heavily sclerotized; cornu is large and broad with large scallops, evenly rounded and rather deeply curved. The cornu is hooked only in *Calendra destructor* Chitt. and not crenulate in this species. In most cases the nodulus and ramus are well developed and distinctly separated. The genitalia is of the compact type and lightly sclerotized; styli are small and borne on distal membranous portion of the coxites. In *Scyphophorus acupunctatus* Gyll. the styli are borne on a chitinized prolongation of the coxites, whereas, in *Schphophorus yuccae* Horn the most distal portion of styli are scleratized. The eighth sternite is sclerotized and greatly modified.

SUB-FAMILY THECESTERNINAE

CHARACTERISTICS OF THE SUB-FAMILY: The spermatheca is very small, narrow and lightly sclerotized; cornu thin, not crenulate and only slightly hooked; nodulus rudimentary and ramus narrow and not distinct from ductus receptaculi. The genitalia is of the compact type and lightly scleratized; coxites are large and heavily sclerotized; styli are borne on the terminal portion of the coxites are very small. The eighth sternite is greatly modified.

FAMILY SCOLYTIDAE

FAMILY CHARACTERISTICS: the spermathecae in this group are the most simple form of any of the Rhynchophora studied. The ducts entering the spermatheca are very close and in certain species is almost indistinguishable; cornu formed by only a slight bend from the nodulus and ramus portion and is slightly hooked in only *Scolytus ventralis* Lec. The ramus is not distinct from the nodulus.

Species of *Scolytus* and *Dendroctonus* were studied but no definite sclerotized genital structures were found. No sclerotization was observed in studies of other genera.

EXTERNAL GENITALIA

The lack of uniformity in the published accounts treating the external female genital structures seem to be partly due to differences in numbering the abdominal segments. The spiracles are useful structures in determining the segmentation because there are only eight pairs of abdominal spiracles in most adult beetles. Some authors

describe the last segment of the abdomen as the tenth while others believe it to be the eleventh. Tanner (1927) states that there are apparently ten segments in the abdomen of most adult beetles and the eleventh somite has been disregarded in his study, as it is only to be found as a membranous remnant around the anal aperture of the tenth tergite. Snodgrass (1935) believes that the tenth segment is present in the abdomen of nearly all insects, but its limits are often difficult to determine because of the frequent union between the tenth and eleventh segments. The terminology used by Tanner in his paper on the study of the genitalia of the female Coleoptera seems to be the most complete and widely used, and will be followed in this study.

The female genitalia consists of the eighth, ninth and tenth abdominal segments and their modified appendages. The last two segments are withdrawn into the abdomen and are extruded only during copulation and oviposition. The eighth sternite is in most cases sclerotized in varying degrees except in certain species in which it is membranous (Figs. 3, 14, 37). In some species it is lightly sclerotized and in these drawings it has been very lightly stippled. When the eighth sternite is membranous it is usually setiferous. In certain cases it is partly divided by a membranous area down the middle, in some it is slightly angulate and in others it is rounded and emarginate at the apex. It is a structure of value in taxonomic work when combined with other features. Since only a ventral view has been studied the eighth tergite has not been closely examined, but it was observed that it has not been modified as extensively as the sternite.

The coxites are ventral appendages on either side of the apex of the female genital tube, presumably borne by the ninth sternite, and carrying the styli. They are usually sclerotized and take on varied forms. Generally they are as just one segment; however, in *Epicaerus wickhami* Pierce (Fig. 54) they are divided into two segments separated by a membranous area. This division of the coxites seems to be an adaptation in connection with the inward and outward movement of the genitalia.

The stylus is a cercus-like appendage borne on the terminal membranous portion of the coxites. In *Scyphophorus acupuenctatus* Gyll. (Fig. 105) the stylus is borne on a sclerotized prolongation of the coxites. In certain species (Figs. 5, 11, 27, 37) there are rodlike structures composed of heavy sclerotized shafts extending from the ninth segment to the coxites. Tanner has proposed that these structures be called baculi. They often act as a support in the elongate genitalia where the genital tube is lightly sclerotized.

The genital chamber receives the median oviduct and serves as a copulatory pouch during mating with its external opening being the vulva. The anus and vulva, in most species, are found in the membranous tenth segment with the vulva located in the coria between the coxites.

Tanner (1927) in his study of the female genitalia recognized two typical forms, the compact and the elongate types. The structures examined in this study belong to these two characteristic patterns. In

the compact type the structures are close together, short and with little separation (Figs. 8, 65, 92) while in the elongate type (Figs. 27, 37, 56) they are usually long, membranous and contain baculi for their support.

The genitalia of this series seem to be the most highly specialized in the Coleoptera. In many species the only genital structures remaining are the coxites and styli. In the scolytids no sclerotized genital structures can be found.

MORPHOLOGICAL STUDY OF SPERMATHECA

Dobzhansky (1931) made a study of the North American beetles of the genus *Coccinella* (Family Coccinellidae) in which he examined the male and female genitalia and the spermathecae. In this study he describes the spermatheca as being clearly differentiated into the cornu, the nodulus and the ramus. In 1947, Davis made a similar study of the tribe Ophryastine (Family Curculionidae) and used the terms adopted by Dubzhansky. Since the work by Davis is concerned with the Rhynchophora his terminology will be followed in this paper.

In the early literature there was some disagreement as to how the spermatheca arises. It was first suggested that is was an outgrowth of the uterus itself or that it was derived from a pair of vesicles situated posterior to the eighth segment. Recent studies indicate that it is primarily an invaginaion of the integument at the posterior end of the venter of the eighth abdominal segment and is connected with a long slender duct to the bursa where it joins the oviduct. The bursa copulatrix is a pouch for the reception of the seminal fluid before it passes to the spermatheca. This chamber receives the median oviduct and the duct of the spermatheca into its anterior end. In almost all cases the spermatheca is found on the right side of the vagina in the eight abdominal segment. The spermatheca, or receptaculum seminis, as it is often referred to, is a sac or sperm receptacle which opens dorsally to the vaginal pore, receives the spermatozoa during copulation and releases them when the eggs are to be fertilized.

The size, shape and degree of sclerotization is highly variable within the series but it is a characteristic that is unique in structure and distinct in form within a given species. While making this study of the spermathecae of the weevils other families of Coleoptera were investigated.

The spermathecae in the Rhynchopora have reached the highest degree in complexity of form over all groups studied. In the families Carabidae, Tenebrionidae, Scarabaeidae, and Cerambycidae the spermathecae are very simple in form, lightly sclerotized and the nodulus and ramus are not well developed. In the family Coccinellidae the nodulus and ramus are well developed and heavily sclerotized. The scultpure of the walls of the spermathecae, consisting of sclerotized, is well developed in all species studied. Usually the spermatheca is a single structure as in the Rhynchophora and other Coleoptera but in some of the insect orders it is paired and often triple. In the Diptera the triple spermathecae are long and very simple in form.

As in most insects the pairing of sexes occurs only once, and since the egg-laying period may extend over a period of years, it is necessary that a provision be made for the storage of the seminal fluid after the union of the sexes. As eggs become full-grown each is provided with a shell before leaving the ovarian tubes. Before an egg is oviposited, one or more spermatozoa is released by the spermatheca and enter into the egg through an opening in the chorion resulting in fertilization. This process is believed to take place as the egg passes from the oviduct into the genital chamber.

Davis has divided the spermatheca into three distinct regions: the ramus, (Figs. 51, 64, & 100) that portion of the spermatheca receiving the seminal fluid; the nodulus, (Figs. 2, 49, & 93) that portion having attachment to the spermathecal gland; and the cornu, (Figs. 21, 53, & 63) the distal end of the spermatheca. The ductus receptaculi is found where the sperm duct enters the ramus portion of the spermatheca. It is an elongation of the ramus and first receives the seminal fluid before it enters into the ramus. In most cases the ductus is very distinctive from the ramus as in Figures 40, 55, and 101. In Figures 76 and 91 the ductus is in very close contact with the ramus and cannot be readily separated.

In many of the specimens studied the nodulus and ramus are heavily scleritized where these two ducts enter the spermatheca. This can very easily be seen in the family Belidae and sub-family divisions of the Curculionidae. As yet no satisfactory explanation has been reached why this variation should occur. It is believed that this scleritized portion of the spermatheca gives added support and aid when releasing the spermatozoa.

During copulation the male discharges the seminal fluid into the genital chamber of the female. The seminal fluid enters the ramus by a tube leading from the genital chamber and is stored in the spermatheca for future use. When fertilization occurs the spermatheca releases a certain amount of seminal fluid and this is discharged from the ramus into a duct leading to the genital chamber. As the egg passes the opening of the spermathecal duct a small amount of seminal fluid is discharged upon the micropyle. Some sperms enter the egg through the micropyle and fertilize it. Thus the egg is inseminated just as it leaves the oviduct. The egg now undergoes its maturation divisions, and shortly after a sperm nucleus unites with the nucleus of the ovum, the fertilized egg is ready for development when the external conditions are favorable.

There is some controversy as to the function of the spermathecal gland and in most studies no function has been proposed. It seems logical that it must have some control or function in connection with the seminal fluid. Snodgrass (1935) states that very commonly a diverticulum of the spermatheca forms a tubular spermathecal gland which secretes a fluid in which the sperms are discharged. On the outer surface of the duct there is a muscular sheath, and the muscle fibers are sometimes so arranged as to form a special pumping apparatus for ejecting the sperms, or a certain quantity of sperm-con-

taining fluid upon each egg as it issues from the oviduct into the genital chamber or vagina.

In most all cases the spermathecal gland is large, tubular in form and consists of thick-walled tissue lined with a thin chitinous sac. Because of their delicate nature many of the sacs were destroyed in dissecting the spermatheca from the specimen and representative comparison could not be made. In the specimens that were studied, it was found that few differences occurred in this gland with the most notable difference being in size. Upon close examination of the spermatheca in many of the specimens, it was noted that a small band of muscles or fiber appears between the tip of the cornu and the ramus. No function of these fibers has been proposed, but from their appearance in a freshly relaxed specimen they seem to aid in supporting the spermatheca in the abdomen of the insect.

In many species and especially in the sub-family Calendrinae, the spermathecae are crenulate and highly scleritized. The cornu is usually the most heavily crenulate with large scallops, evenly rounded and rather deeply curved. This is one distinguishing character that separates this sub-family from the others. In the genus *Lixus* (Curculioninae) the ramus is the only portion that is crenulate with the cornu being regular. The degree of crenulation seems to be a generic characteristic of the spermathecae.

SUMMARY

1. This study of the genitalia and spermatheca of the Rhynchophora has included eighty-two species as listed in Leng's Catalogue together with seven species from the Philippine Islands and one from China.

2. On the basis of the female genitalia and spermatheca the specimens studied may be divided into eight and possibly nine well-defined groups. This is in agreement with previous studies.

3. The evolution of the genitalia has been from the complex to the simple structures and the spermatheca appears to have evolved from the simple to the complex and then back to the simple form.

4. The spermatheca in the family Belidae resembles more closely that of the Curulionidae than it does the Platystomidae. This is in agreement with Ting and he suggests a shift of this family from the position it now holds in Leng's Catalogue.

5. On the basis of the spermathecae, there is no sharp line of demarcation between the Otiorhynchinae and Curculioninae.

6. The spermatheca of the Pterocolinae shows closer relationship to the Rhynchitinae than it does to the Attlabinae.

7. The genitalia and spermatheca are useful in taxonomic work and are of value in generic as well as specific separation.

8. The value of the spermathecae is limited because they are not available for interpretation without mutilating the specimen, which in the case of rare or unique specimens would not be advisable.

EXPLANATION OF PLATES

The various species studied have been grouped in what seems to be their most logical sequence based on the external genitalia and the spermatheca. The figures have been enlarged from the original and the magnifications listed for only the spermatheca of each species examined. Since no drawings were made before the structures were mounted, only a ventral aspect of the genitalia was figured. Those areas that are scleritized are indicated in two ways, either by a solid black area or as unstippled areas. The membranous portions are lightly stippled.

Because of the delicate nature of the spermathecal gland, it often becomes detached from the nodulus portion of the spermatheca and for this reason it has not been included in all the drawings. The duct attaching to the ramus is very long and only a short portion has been shown. In the drawings the ducts labeled "spd" represent the place where the spermathecal gland and duct from the ramus have been detached from the spermatheca. The ducts attached to the spermatheca are not as heavily scleritized as they appear in certain figures. In cases where both of these structures are included in the plates, the genitalia precedes the spermatheca.

The following abbreviations have been used:

(cu)—cornu
(nd)—nodulus
(rm)—ramus
(dr)—ductus receptaculi
(spg—spermathecal gland
(spd)—spermatheca duct
(c)—coxites
(sty)—styli
(b)—baculum
(v)—vulva
(8ths)—eighth sternite
(9ths)—ninth sternite

PLATE I

Ectocemus 10-maculatus Montr. P. Islands. 43x. Figs. 1 & 2.
Eurymycter fasciatus (Oliv.) 43x. Figs. 3 & 4.
Euparius lugubris (Oliv.) 43x. Figs. 5 & 6.
Anthribus cornutus Say. 115x. Fig. 7.
Phoenicobiella chamaeropis Lec. 43x. Figs. 8 & 9.
Araeocerus fasciculatus (DeG.) 115x. Fig. 10.
Rhinomacer elongatus Lec. 43x. Figs. 10 & 11.
Euparius marmoreus (Oliv.) 43x. Fig. 13.
Rhynchites bicolor Fab. 43x. Figs. 14 & 15.
Rhynchites aeneus Boh. 43x. Fig. 16.
Pterocolus ovatus (Fab.) 115x. Figs. 17 & 18.
Attelabus analis Ill. 115x. Fig. 19.
Attelabus rhois Boh. 115x. Fig. 20.
Apion porcatus Boh. 115x. Fig. 21.
Apion rostrum Say. 115x. Fig. 22.
Cylas formicarius (Fab.) 115x. Fig. 23.
Ithycerus noveboracensis (Forst.) 115x. Figs. 24 & 25.
Metapocyrtus chevrolati Waterh. P. Islands. 43x. Fig. 26.
Apocyrtus inflatus Erichs. P. Islands. 43x Figs. 27 & 28.
Metapocyrtus profanus Erichs. P. Islands. 43x. Fig. 29.
Ophryastes vittatus (Say). 43x. Fig. 30.
Ophryastes latirostris Lec. 43x. Fig. 31.

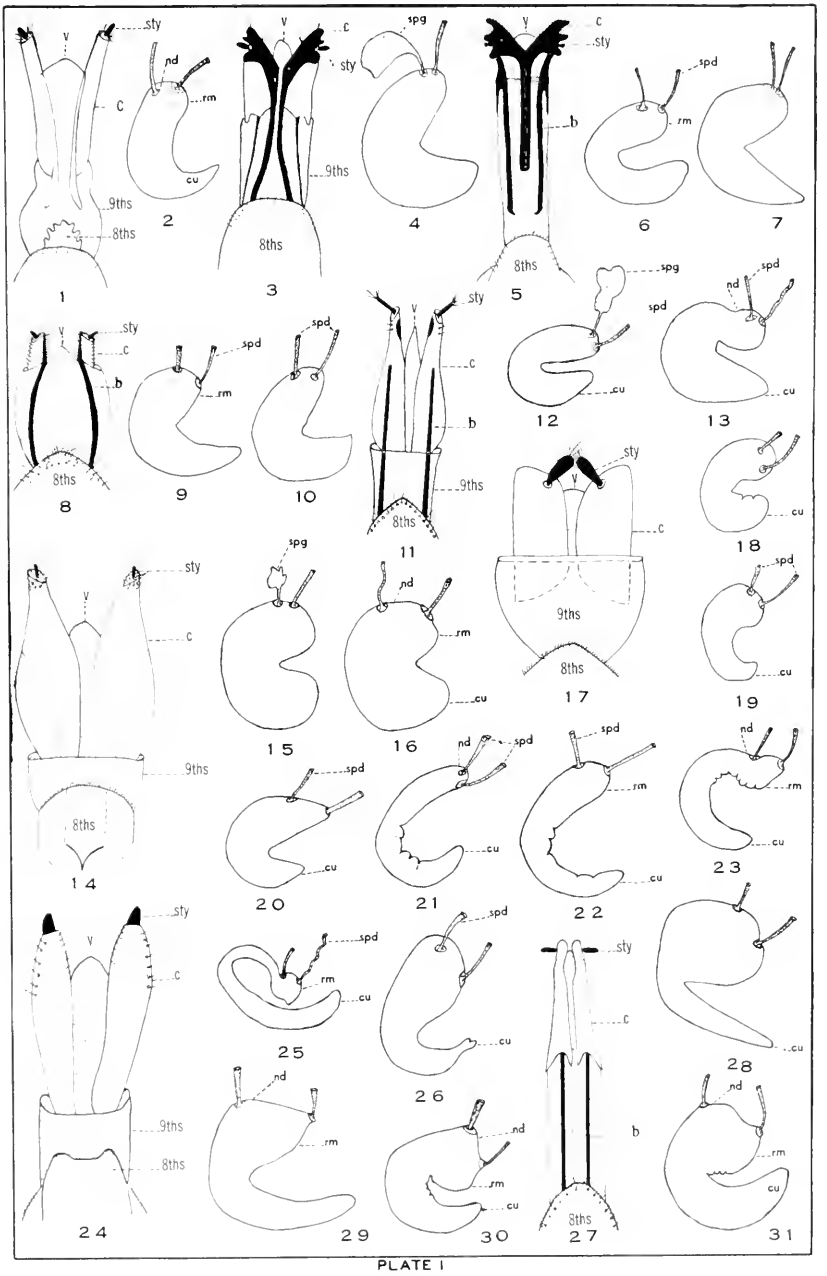

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
sty
v
c
9ths
8ths
nd
rm
cu
spg
sty
b
spd

PLATE I

PLATE II

Metapocyrtus gregarius Erichs. Luzon, P. Islands. 43x. Fig. 32.
Ophryastes sulcirostris (Say) 43x. Fig. 33.
Eupagoderes sordidus (Lec.) 43x. Fig. 34.
Pandeleteius hilaris (Hbst.) 43x. Fig. 35.
Eupagoderes desertus Horn. 43x. Fig. 36.
Cyphus placidus Horn. 43x. Figs.37 & 38.
Eupagoderes nivosus Fall. 43x. Fig. 39.
Eupagoderes argentatus (Lec.) 43x. Fig. 40.
Dyslobus wasatchensis Tanner. 43x. Fig. 41.
Melamomphus alternatus (Horn) 115x. Fig. 42.
Episomus lentus Erichs. Luzon, P. Islands. 43x. Figs. 43 & 44.
Compsus auricephalus (Say) 43x. Figs. 45 & 46.
Brachyrhinus sulcatus Fab. 43x. Fig. 47.
Panscopus aequalis (Horn) 43x. Figs. 48 & 49.
Miloderes setosus Say. 43x. Figs. 50 & 51.
Scythropus elegans (Couper) 43x. Fig. 52.
Scythropus californicus Horn. 43x. Fig. 53.
Epicaerus wickhami Pierce. 43x. Figs. 54 & 55.
Hormorus undulatus (Uhler) 43x. Figs. 56 & 57.
Polyarusus americanus Gyll. 43x. Fig. 58.

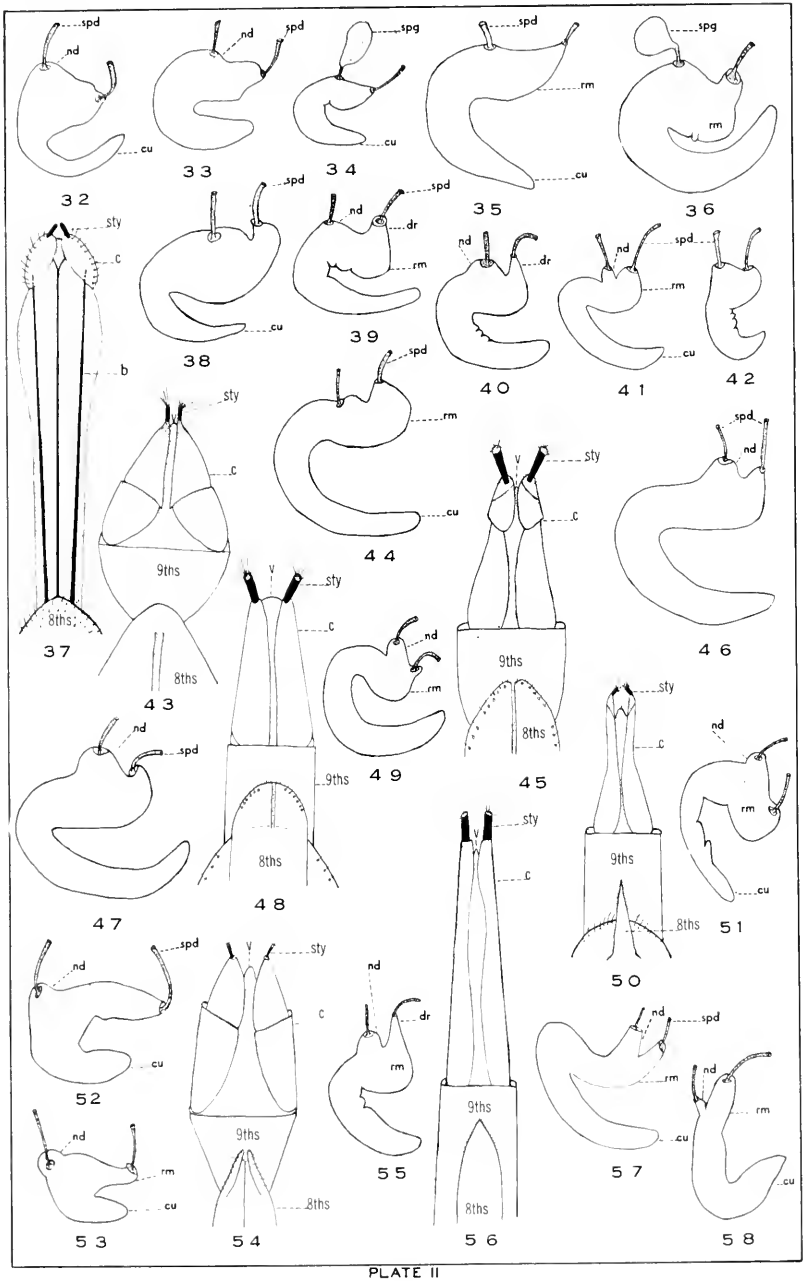

spd
nd
cu
32
33
spg
34
rm
35
36
sty
c
b
37
9ths
8ths
38
dr
39
40
41
42
43
44
v
45
46
47
48
49
50
51
52
53
54
55
56
57
58

PLATE II

PLATE III

Hypomeces squamous Fab. Canton, China, 43x. Figs. 59 & 60.
Pantomorus pallidus (Horn) 43x. Fig. 61.
Pantomorus fulleri (Horn) 43x. Fig. 62.
Hypera punctata (Fab.) 43x. Fig. 63.
Geodarces incomptus Horn. 43x. Fig. 64.
Phytonomus eximius Lec. 43x. Figs 65 & 66.
Phytonomus nigrirostris (Fab.) 43x. Fig. 67.
Phytonomus meles (Fab.) 43x. Fig. 68.
Phytonomus posticus (Gyll.) 43x. Fig. 69.
Anthonomus scutellaris Lec. 43x. Fig. 70.
Anthonomus grandis Boh. 115x. Fig. 71.
Tychius lincellus Lec. 43x. Fig. 72.
Listronotus callosus Lec. 43x. Figs. 73 & 74.
Listronotus caudatus (Say) 43x. Fig. 75.
Pachylobius picivorus (Germ) 43x. Fig. 76.
Dorytomus brevisetosus Csy. 43x. Fig. 77.
Pissodes strobi (Pack) 43x. Figs. 78 & 79.
Alcides schonherri Jekel. 43x. Figs. 80 & 81.
Pissodes affinis Ran. 43x. Fig. 82.
Notaris puncticollis (Lec.) 115x. Fig. 83.
Magdalis lecontei Horn. 115x. Fig. 84.
Magdalis substriga Fall. 115x. Fig. 85.
Magdalis gentilis Lec. 115x. Fig. 86.
Balaninus proboscideus (Fab.) 43x. Fig. 87.
Cryptorhynchus parochus (Hbst.) 115x. Fig. 88.
Rhinoncus pyrrhopus Boh. 115x. Fig. 89.

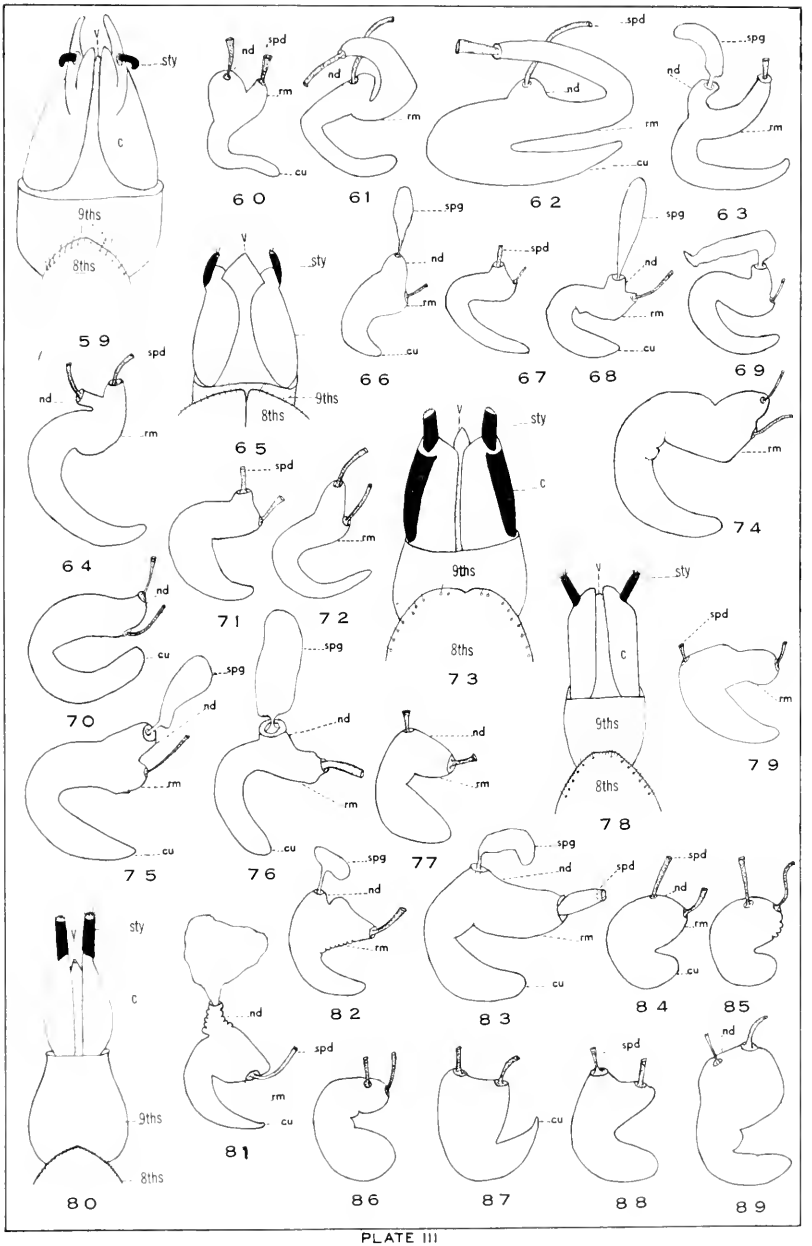

V
sty
c
9ths
8ths
59
nd
spd
rm
cu
60
61
62
spg
63
65
64
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
89

PLATE III

PLATE IV

Balaninus caryae Horn. 43x. Fig. 90.
Balaninus baculi Chitt. 43x. Fig. 91.
Lepyrus palustris Scop. 43x. Figs. 92 & 93.
Balaninus rectus Say. 43x. Fig. 94.
Balaninus strictus Csy. 43x. Fig. 95.
Balaninus victoriensis Chitt. 43x. Fig. 96.
Dinocleus albovestitus Csy. 115x. Fig. 97.
Cleonus calandroides (Band.) 115x. Fig. 98.
Lixus concavus Say. 43x. Fig. 99.
Lixus terminalis Lec. 43x. Fig. 100.
Lixus scrobicollis Boh. 43x. Fig. 101.
Thecesterus humeralis (Say) 43x. Figs. 102 & 103.
Calendra destructor Chitt. 115x. Fig. 104.
Scyphorus acupunctatus Gyll. 43x. Figs. 105 & 106.
Scyphophorus yuccae Horn. 43x. Figs. 107 & 108.
Rhodobaenus tredecimpunctatus (Ill.) 43x. Fig. 109.
Calendra ochreus Lec. 43x. Fig. 110.
Calendra costipennis (Horn) 43x. Figs. 111 & 112.
Calendra zeae Walsh. 115x. Fig. 113.
Calendra parvulus Gyll. 43x. Fig. 114.
Scolytus ventralis (Oliv.) 115x. Fig. 115.
Dendroctonus terebrans (Oliv.) 115x. Fig. 116.
Dentroctonus valens Lec. 115x. Fig. 117.

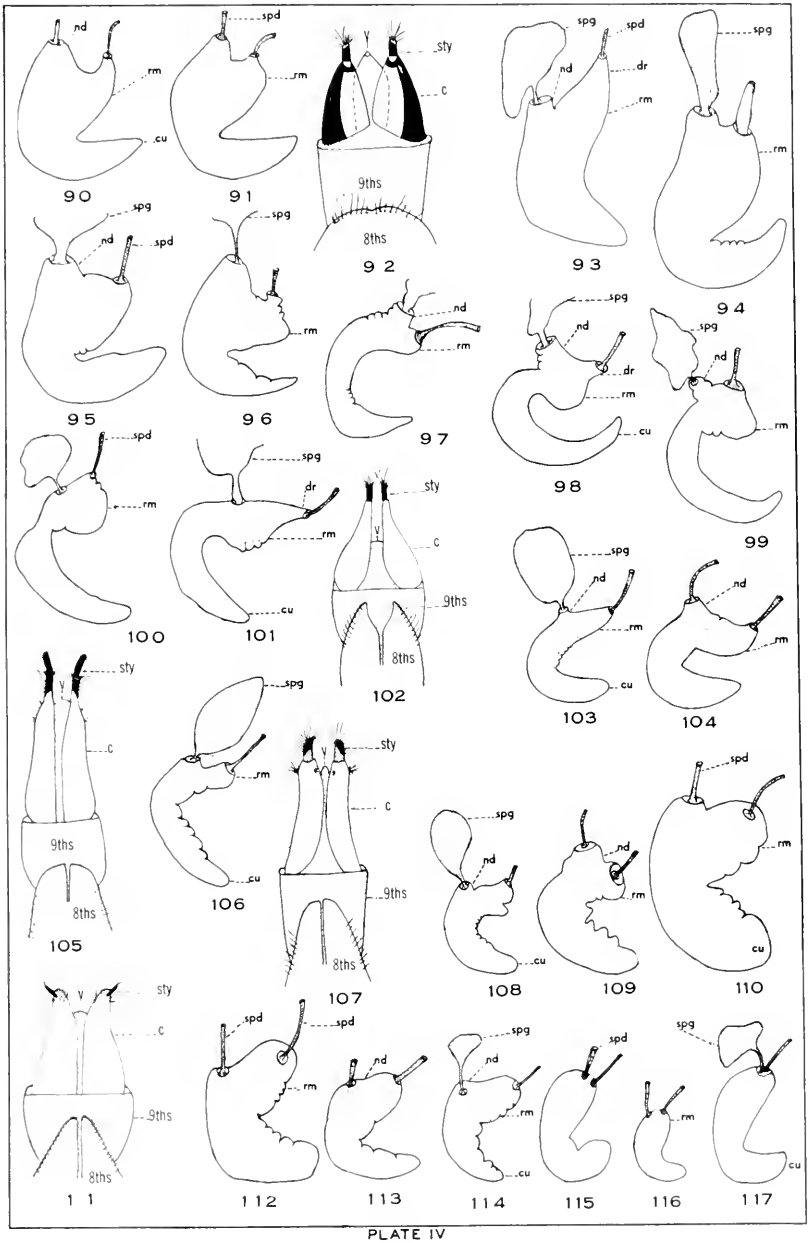

90
nd
rm
cu
91
spd
rm
92
sty
c
9ths
8ths
93
spg
spd
nd
dr
rm
94
spg
rm
95
spg
nd
spd
96
spg
rm
97
nd
rm
98
spg
nd
dr
rm
cu
99
spg
nd
rm
100
spd
rm
101
spg
dr
rm
cu
102
sty
c
9ths
8ths
103
spg
nd
rm
cu
104
nd
rm
105
sty
c
9ths
8ths
106
spg
rm
cu
107
sty
c
9ths
8ths
108
spg
nd
cu
109
nd
rm
110
spd
rm
cu
111
sty
c
9ths
8ths
112
spd
spd
rm
113
nd
114
spg
nd
rm
cu
115
spd
116
rm
117
spg
cu

PLATE IV

LITERATURE CITED

Blatchley, W. S., and C. W. Leng, 1916. Rhynchophora or Weevils of North-Eastern America. The Nature Publishing Co., Indianapolis.

Bruhn, Arthur F., 1947. The External Male Genitalia of Some Rhynchophora. Great Basin Naturalist. Vol. VIII. Nos. 1-4, pp. 1-35.

Davis, Alonzo G., 1947. Review of the Weevils of the Tribe Ophryastini of America North of Mexico. Proc. U. S. Nat. Mus., Vol. 96, No. 3207, pp. 483-551.

Dobzhansky, Th., 1931. The North American beetles of the Genus Coccinella. Proc. U. S. Nat. Mus., Vol. 80, pp. 1-32, figs. 1-30.

Huxley, Julian, 1949. The New Systematics. The Oxford Univ. Press. London.

Leng, C. W., 1920. Catalogue of the Coleoptera of America North of Mexico. J. D. Sherman, Mt. Vernon, N. Y.

Leng, C. W., and A. J. Mutchler, 1933. Second and Third Supplements of the Catalogue of the Coleoptera of America North of Mexico.

Macgillivary, Alex D., 1923. External Insect Anatomy, Scrab Co., Urbana, Ill.

Mayr, Ernst, 1949. Systematics and the Origin of Species. Columbia Univ. Press, New York. pp. 216-275.

Snodgrass, R. E., 1935. Principles of Insect Morphology. Chapt. XVIII and XIX. pp. 550-623. McGraw-Hill, N. Y.

Tanner, Vasco M., 1927. A Preliminary Study of the Genitalia of the Female Coleoptera. Trans. Amer. Ent. Soc., Vol. 53, No. 900, pp. 5-50.

——1943. A Study of the subtribe Hydronomi with a description of new species. Great Basin Naturalist. Vol. 4, Nos. 1 & 2, pp. 1-38.

Ting, P. C., 1936. The Mouthparts of the Coleopterous Group Rhynchophora. Microentomology. Vol. 1, No. 3, pp. 93-114.

TWO NEW SPECIES OF WEEVILS OF THE TRIBE CELEUTHETINI (COLEOPTERA)[1]

Vasco M. Tanner

Moluccobius marshalli sp. n.

Body in male and female black to red-brown, with pale green scales above; prothorax with a broad medium black stripe bordered by sublateral green stripes, which form concentric lateral figures centered by black areas devoid of scales; lower half of pleurae to the coxae covered with a continuum of sparce pale green scales; elytra with markings of scales as shown in Figure 1; a crescent band of scales extending from the base of interval 3 along the humeral region and laterally back along intervals 8 to 10 to the middle; interrupted band of scales at the middle; two spots below the declivity. Underside, mesosternum, metasternum and the ventrites sparsely covered with pale green scales.

Head smooth, except for a small medium fovea on the sulcus which separates the head from the rostrum. On many specimens this fovea is obscured by the dense covering of scales. Eyes moderately convex; Rostrum longer than broad in the females, as broad as long in the males; dorsal area with a fine medium sulcus in the dense scales; Antennae scape reaching to the middle of the prothorax, covered with white recumbent setae and small scales; funicle reaching the anterior two-fifths of the elytra; segment 2 a fourth longer than segment 3; Prothorax as long as broad, widest a little beyond the middle; dorsum convex, with deep close punctures, the intervals narrower than the punctures, with small shiny granules bearing a short recumbent white, brown, or black seta; the broad medium stripe bordered with long green scales, Figure 1. Elytra broadly ovate, widest before the middle; the striae with shallow round punctures devoid of setae; the broad intervals with small shiny granules bearing a recumbent seta; erect setae beyond the declivity along the suture; pale green scales forming a lunula in the humeral area; an interrupted band of scales at the middle and two prominent spots below the declivity. Legs red-brown to black covered with grey or pale coppery scales and decumbent white setae on the dorsal; femora moderately clavate, first and second tibiae mucronate, metatibia with open corbel, spinules of distal comb amber color and longer than those of anterior comb; third tarsal segment twice as wide as the second and with heavy tufts of yellow pubescence. Aedeagus of the male spatulate Figs. 2 and 3, spermatheca Fig. 4.

Length: 3-5.5 mm. Breadth: 2-3 mm.

Type and 105 paratypes collected by Ernest Reimschiissel between October and December 1944, at the U. S. Pitu Military Airfield which was located between Pitoeo and Sabatai on Morotai Island. Paratypes have been deposited in the following institutions: British Museum, Natural History; U. S. National Museum; California

1. Contribution No. 172, Department of Zoology and Entomology, Brigham Young University.

Academy of Sciences; Museum, G. Frey, Tutzing; and Brigham Young University.

REMARKS: *Marshalli* is closely related to *wallacei*. It differs in

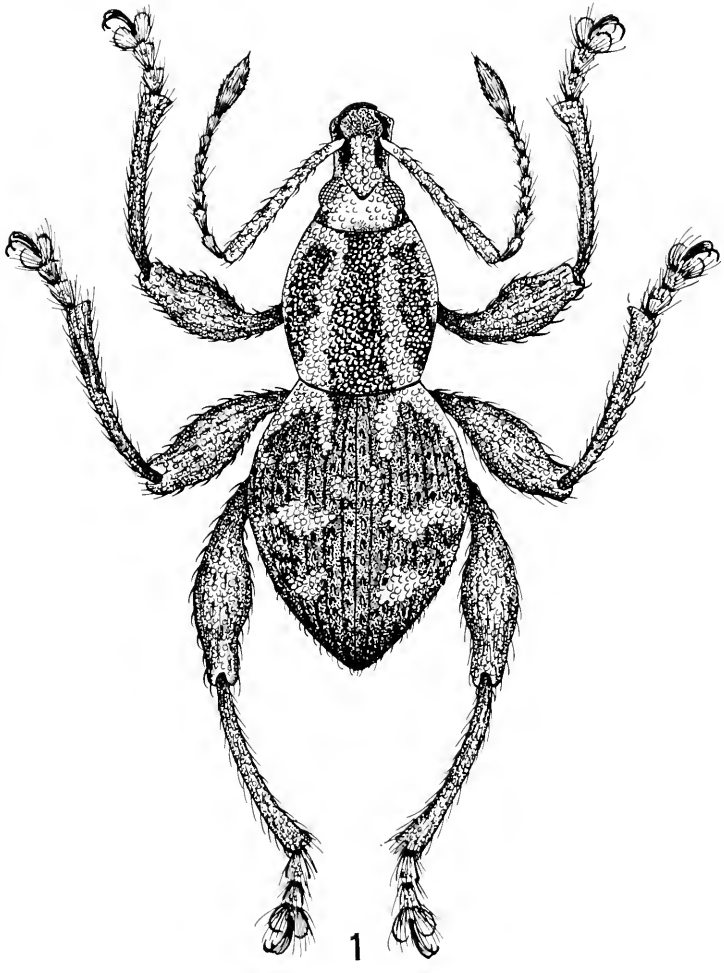


Fig. 1. *Moluccobius marshalli* sp. n.

scale pattern of the prothorax and elytra, is smaller and the aedeagus is broadly rounded not pointed, Fig. 2; *Marshalli* is fairly abundant on the vegetation around the Pitu Airfield at Pitoeo on Point Gila of

Morotai Island. Mr. Ernest Reimschiissel, the collector, reported that he found it feeding on the sap which was exuding from damaged trees, in the open area around the military quarters.

Specimens of this species along with many other species from the Solomon, Admiralty and Moluccas Islands were submitted to Sir Guy Marshall of the British Museum of Natural History who report-

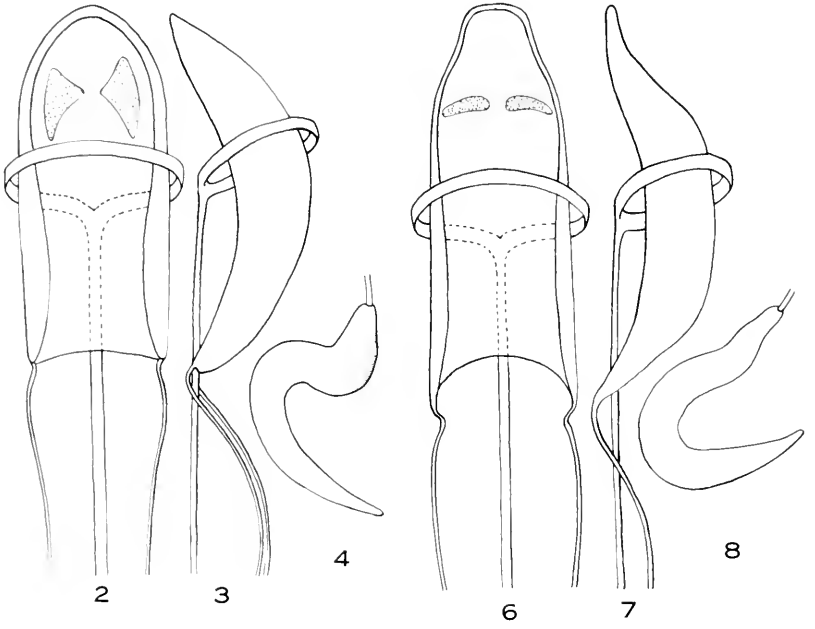


Fig. 2. *Moluccobius marshalli* sp. n. Dorsal view of median lobe of male.
Fig. 3. *Moluccobius marshalli* sp. n. Lateral view of the median lobe of male.
Fig. 4. *Moluccobius marshalli* sp. n. spermatheca.
Fig. 6. *Lophothetes reimschiisseli* sp. n. Dorsal view of median lobe of male.
Fig. 7. *Lophothetes reimschiisseli* sp. n. Lateral view of the median lobe of male.
Fig. 8. *Lophothetes reimschiisseli* sp. n. spermatheca.

ed that several of them including this species of *Moluccobius* were new species. I am pleased to name this species in honor of Sir Guy Marshall, who was an outstanding authority on the weevils and a kind helper and cooperator. He assisted me in my study of the weevils while at the British Museum in 1957, and was very generous in giving to me Cotypes of many species of weevils he had recently described, along with specimens of 32 species of described Curculionids from Africa.

KEY TO THE SPECIES OF MOLUCCOBIUS*

1 (8) Prothorax as long as broad or a little longer; scape of antennae nearly reaching middle of prothorax; head not carinulate.
2 (7) Pronotum closely punctate, the punctures on the disk as wide or wider than the intervals, though often partly obscured by scales.
3 (4) Front femora very strongly arcuate on the dorsal edge; pronotum with a complete white stripe on each side; elytra with two complete white bands (interrupted only by the suture) (New Guinea) ..... *ligatus Pasc.*
4 (3) Front femora normal; pronotum with a lateral stripe of bluish green scales on the basal half only, or without any stripe; elytra with more or less greenish scales and without white bands.
5 (6) Pronotum with a broad green stripe on each side on the basal half and a narrow median stripe on the apical half; elytra with blackish scales and various definite green spots; aedeagus of ♂ terminating in the form of a pointed spoon (Kaioa, Halmaheira) ..... *wallacei Mshl.*
5 (6a) Pronotum with a broad medium area, bordered by lateral stripes of pale green scales; the lateral stripes are joined apically by a submarginal band of scales; elytra with a crescent-shaped band of scales extending along the humeral area and laterally back along intervals 8 to 10; an interrupted band of scales at the middle; Aedeagus spatulate in shape (Moluccas: Morotai Island) ..... *marshalli* sp. n.
6 (5) Pronotum and elytra without definite green stripes or spots, but with numerous pale green, pale coppery and grey scales; aedeagus of ♂ terminating in two long processes turning up into a sharp hook at the apex (Batchian) ..... *uncifer Mshl.*
7 (2) Pronotum nearly devoid of scales in the middle, sparsely punctate, the intervals on the disk much wider than the punctures (Morty, Batchian, Halmaheira) ..... *notatus Mshl.*
8 (1) Prothorax transverse; scape of antennae only shortly exceeding front margin of prothorax; head carinulate (Aru Is.) .. *brevicornis Mshl.*

*Sir Guy Marshall's key to the species of *Moluccobius*, p. 41.

Lophothetes reimschiisseli sp. n.

Body black, antennae and legs red-brown, with small regular grey scales; prothorax evenly punctate. Punctures larger than the intervals; scales arranged around the punctures in circular figures; elytra with uniform coverage of grey scales and recumbent brown setae on the intervals; small tuft of erect setae on the declivity of the suture of the females; ventrite 2 longer than 3 - 4 - 5.

Head smooth with shallow punctures surrounded with round grey scales, the eyes round, large and greatly convex.

Rostrum longer than broad widening apically with an abrupt apical declivity, which is sparsely squamose; the narrow space between the scrobes as wide as the apex of the scape; frons separated from the rostrum by a sulcus that extends downward in contact with the eyes. Antennae stout, the scape extends beyond the middle of the prothorax; funicle reaches the middle of the elytra; segments 1 and 2 equal, segments 3 to 7 as broad as long. Prothorax with the truncate base wider than the apex; rounded laterally, widest behind the middle, with no granules; elytra uniform color, widest before the middle, striae distinct but shallow with small punctures, intervals

twice the width of the striae, with a yellow-brown decumbent setae, males devoid of a tuft of setae on the suture, tuft present in the females. LEGS with hind femora not reaching the apex of the elytra;

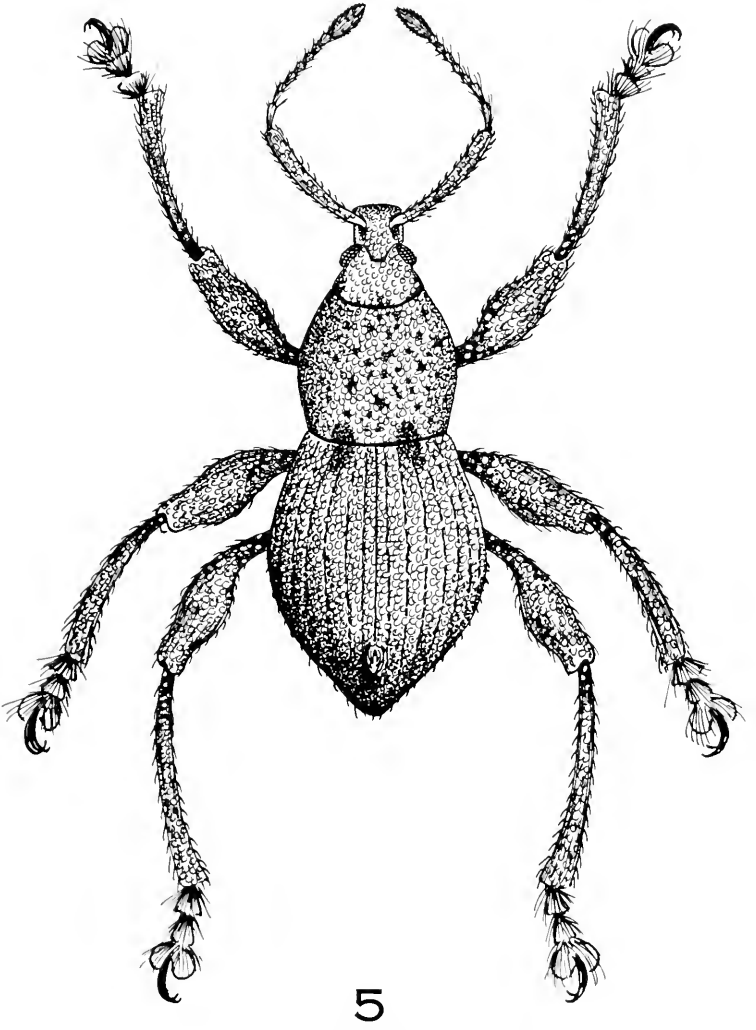


Fig. 5. *Lophothetes reimschiisseli* sp. n.

femora moderately clavate, tibiae not denticulate, segment 3 of the tarsi with erect whitish setae, more than twice as wide as the second segment. AEDEAGUS Figs. 6 and 7; spermatheca Fig. 8.

Type and 38 paratypes collected by Ernest Reimschiissel in September 1944, at Manus, Admiralty Islands. Paratypes have been deposited in the following institutions: British Museum, Natural History; U. S. National Museum; California Academy of Sciences; Museum, G. Frey, Tutzing; and Brigham Young University.

REMARKS: *Reimschiisseli* is similar to the genotype *penicilliger* (Heller) found on New Britain. The similarity is drawn from the description given by Heller. The spermatheca and aedeagus are different from species of this genus found on Guam.

LITERATURE CITED

Marshall, Sir Guy A. K. 1956. The Otiorrhynchine Curculionidae of the tribe Celeuthetini (Col.) British Museum. pp. 1-134.

Zimmerman, Elwood C. 1942. Insects of Guam - 1. Curculionidae of Guam. pp. 73-146. pls. 1-7.

TINGIDAE: NEW GENERA, SPECIES, HOMONYMS, AND SYNONYMS (HEMIPTERA)

Carl J. Drake[1] and Florence A. Ruhoff[1]

In compiling a catalogue of the Tingidae of the world, the authors have found a number of synonyms, homonyms, taxonomical and other errors in the literature needing attention. To rectify these errors, it has been necessary to create two new genera, to propose three new trivial names, and to transfer sixteen species to other genera. The drawings were made by Arthur Smith, British Museum (Natural History), Patricia J. Hogue, Arlington, Va., and Caroline B. Lutz, U.S. National Museum. The illustrations were made possible by means of a grant in aid by the National Science Foundation (04095). For the loan of the types of the tingids described by Victor Signoret, from the Malagasy Region, we are indebted to Dr. Max Beier, Naturhistorisches Museum, Vienna, Austria.

New Combinations

Tingis mjöbergi Horváth (1925), *T. assamensis* Distant (1903), *Perissonemia electa* Drake and Poor (1937), *P. dignata* Drake and Poor (1937), and *P. malaccae* Drake (1942) are here transferred to the genus *Ulonemia* Drake and Poor (1937); *Teleonemia nigerrima* Schouteden (1923) to the genus *Perissonemia* Drake and Poor (1937); *Monanthia gibba* Fieber (1844) to the genus *Physatocheila* Fieber (1844); *Monanthia sufflata* Drake and Poor (1939) to the genus *Naochila* Drake (1957); *Leptopharsa celebratis* Drake (1928) and *L. pauxilla* Drake and Poor (1939) to the genus *Vatiga* Drake and Hambleton (1946); *Diplocysta nimia* Drake (1927) and *D. opiparia* Drake (1927) to the genus *Penottus* Distant (1903); and *Cysteochila nexa* Distant (1903) to the genus *Baeochila* Drake and Poor (1937).

Dictyla flavipes (Signoret)

Monanthia flavipes Signoret, (1861) Ann. Soc. Ent. France, ser. 3, vol. 8, p. 956.

The Signoret Collection contains three specimens of this species from Mayotte, one of the Comoro Islands near Madagascar. As the three specimens are all mounted on the same rectangular, cellophane point, we are here designating the male specimen on the left side of this point as the lectotype. Numerous other specimens from the Island of Madagascar have also been studied.

Ambotingis, n. gen.

Fig. 1

Moderately large, distinctly lacy in appearance. Head short, only slightly produced in front of the eyes, strongly declivent, armed with five spines, the median spine situated near the middle of vertex;

1. Smithsonian Institution, Washington, D.C.

eyes large, transverse; bucculae wide, areolate, closed in front; antenniferous tubercles short, bluntly rounded, not spine-like. Antennae

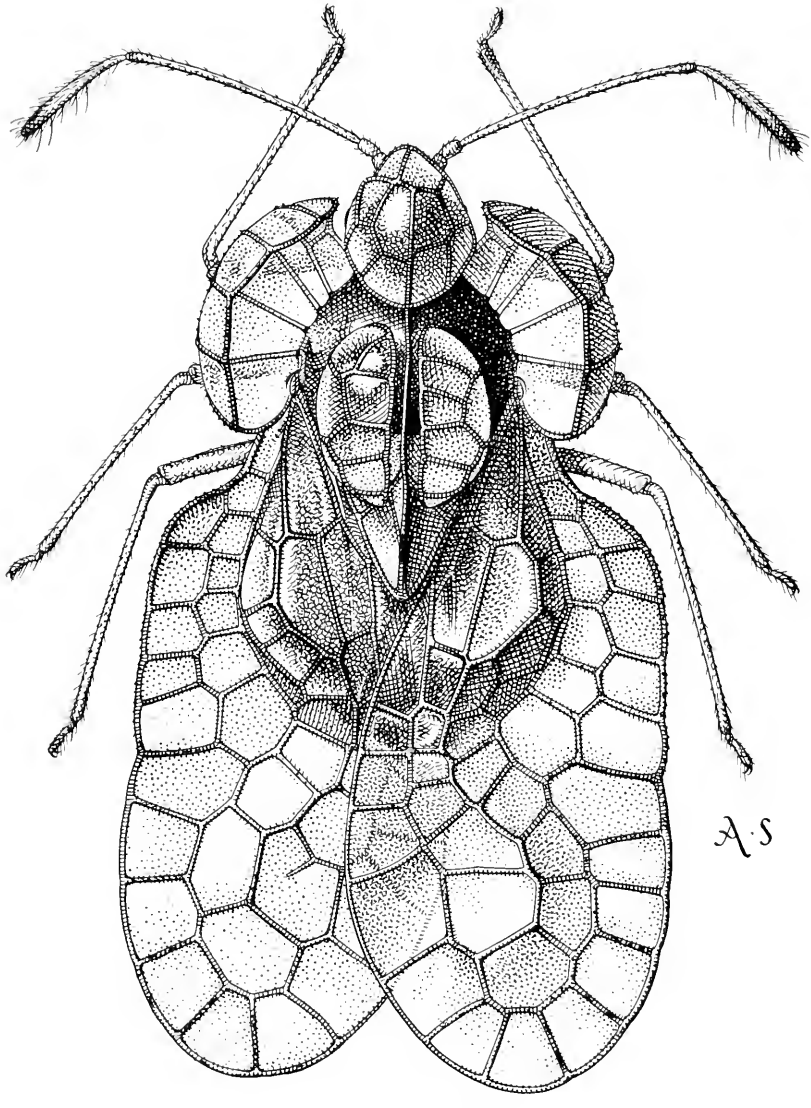


Fig. 1. *Ambotingis senta* (Drake and Hambleton).

very slender, first two segments short, third segment long and very slender, fourth segment rather short, slightly swollen. Rostrum long,

extending on mesosternum; sternal laminae of rostral sulcus wide, uniseriate, nearly parallel on mesosternum, almost twice as widely separated from each other on metasternum, then slowly convergent posteriorly, either open or closed by a low transverse ridge at the base. Hypocostal lamina uniserate. Scent glands of metathorax without visible ostiole and ostiolar sulcus on each metapleuron. Legs slender, moderately long.

Pronotum moderately convex, finely punctate, mostly concealed by reflexed paranota, tricarinate; median carina long, terminating anteriorly, at base of small hood; lateral carinae concavely convergent anteriorly, terminating anteriorly close to median carina just under posterior part of paranota; hood very small, inflated; paranota reflexed, very large, with outer margin touching median carina, sharply elevated near humeral angle and between there and median carina so as to form two narrow, slightly inflated, very high, longitudinal ridges (fig. 1); posterior process triangular, areolate. Elytra much wider than abdomen, divided into the usual areas; costal area very wide, with areolae large and clear; subcostal area wide, with areolae much smaller than those in costal area; discoidial area extending backwards beyond middle of elytra, with the large, semicircular area at apex extending deeply into subcostal area; areolae of discoidal, subcostal, and basal two-thirds of sutural areas about equal in size Outer margins of paranota and elytra and many veinlets of paranota and elytra, and the pronotal carinae armed with short, sharp spines. Metathoracic wings large, functional.

Type species, *Monanthia senta* Drake and Hambleton (1942) from Peru (fig. 1).

Allied to the genus *Dictyla* Stal and readily separated from it by the widely expanded elytra, large areolae in costal area, and especially by the two, sharply, strongly raised longitudinal, slightly inflated cariniform elevation on each paranotum. A paratype of *A. senta* (Drake and Hambleton) is illustrated, (fig. 1).

Cysteochila nigriceps (Signoret), n. comb.

Monanthia nigriceps Signoret, 1861, Ann. Soc. Ent. France, Ser. 3, vol. 8, p. 955.

This species is represented in the Signoret Collection by the type specimen from Sainte-Marie, an island off the coast of Madagascar. It belongs to the genus *Cysteochila* Stal, and it is here so transferred. Several other specimens from Madagascar are also at hand.

Amblystira amica Drake, n.n.

Amblystira solida Drake, 1942, Iowa State College Jour. Sci., vol. 17, p. 17.

During the printing operation, after page proof had been read, an accident made it necessary for the printer to reset the type for page 17. In resetting the type, the specific name "*solida*" (used on previous page for another species) was wrongly inserted for "*amica*" as written in the original manuscript. The trivial name *amica* is here proposed to replace that of *solida* (primary homonym) on page 17 (not *solida* on page 16).

Dulinius unicolor (Signoret) n. comb.

Figs. 2, 3

Tingis unicolor Signoret, 1861, Ann. Soc. Ent., France, Ser. 3, vol. 8, p. 955.
Dulinius nigrolineatus Distant, 1913, Trans. Linnaean Soc., London, vol. 16, p. 158, pl. 11, fig. 16. (New synonymy).
Galeatus involutus Drake, 1925, Entom. Mitteilungen, vol. 14, p. 108. (New synonymy).

This species is represented in the Signoret Collection by a single specimen (holotype) in a very poor state of preservation. Only one elytron is present on the rectangular card, the antennae, paranota, and carinae being missing. By comparing the elytron of the type with other specimens from Madagascar, it was possible to identify positively *unicolor* Signoret, which is here transferred to the genus *Dulinius* Distant.

An examination of the types of *Dulinius nigrolineatus* Distant from the Seychelles and of *Galeatus involutus* Drake from Madagascar shows that these two species are identical and inseparable from *unicolor*, thus both are synonyms of *D. unicolor* (Signoret) (new synonyms). The type of *D. nigrolineatus* (fig. 2) is in the British Museum (Natural History), and is illustrated. We also have typical specimens of *unicolor* from Uganda (Kampala), which were collected on "musenoso".

Tingis (*Tropidocheila*) *marrubii* Vallot

Tingis marrubii Vallot, 1829, Acad. Sci., Arts et Belles-Lettres, de Dijon, p. 98.
Monanthia kiesenwetteri Mulsant and Rey, 1852, Ann. Soc. Linn. Lyons, p. 135. (New synonymy).
Monanthia villosa Costa, 1852, Cim. Neap. p. 11.
Lasiotropis kiesenwetteri Stal, 1874, Ofv. Vet.-Ak. Förh., p. 56.
Tingis kiesenwetteri Horváth, 1906, Ann. Mus. Nat. Hungarici, vol. 4, p. 81.

This species, described as *Tingis marrubii* Vallot (1829), has been entirely overlooked in the literature. The type series, both adults and nymphs, were collected on "marrube blanc" (*Marrubium* Sp.) Since the technical names of *Tingis marrubii* Vallot (1829) and *Monanthia kiesenwetteri* Mulsant and Rey (1852) apply to the same species and since the former name has priority by 27 years, it is here designated as the valid specific name for the species. *T. marrubii* is widely distributed in Europe, Northern Africa, and Asia Minor.

Tingis aetheria, n.n.

Tingis (*Lasiotropis*) *wollastoni* China, 1938, K. Svenska Vet.-Akad, vol. 30, p. 20, fig. 3.

Since the specific name *Tingis wollastoni* China (1938) is a primary homonym of the fossil tingid described as *Tingis wollastoni* Heer (1865), we are here proposing the name of *T. aetheria* for the African tingid described by Dr. China as *Tingis wollastoni*. The reasons for this homonymy are stated in the next paragraph under the caption of *Oncochila wollastoni* (Heer).

Oncochila wollastoni (Heer), n. comb.

Tingis wollastoni Heer, 1865, Die Urwelt der Schweiz, fig. 307; 1872, Monde Primitif de la Suisse, fig. 307; 1876, The primaeval world of Switzerland,

fig. 307; 1879, Die Urwelt der Schweiz, 2nd edition, fig. 307. —Scudder, 1891, U.S. Geol. Survey Bull. no. 71, p. 449.

Monanthia wollastoni Heer, 1865, Die Urwelt der Schweiz, p. 392; 1872, Monde Primitif de la Suisse, p. 480; 1876, The primaeval world of Switzerland, p. 50; 1879, Die Urwelt der Schweiz, 2nd edition, p. 417. —Scudder, 1891, U.S. Geol. Survey Bull. no. 71, p. 422.

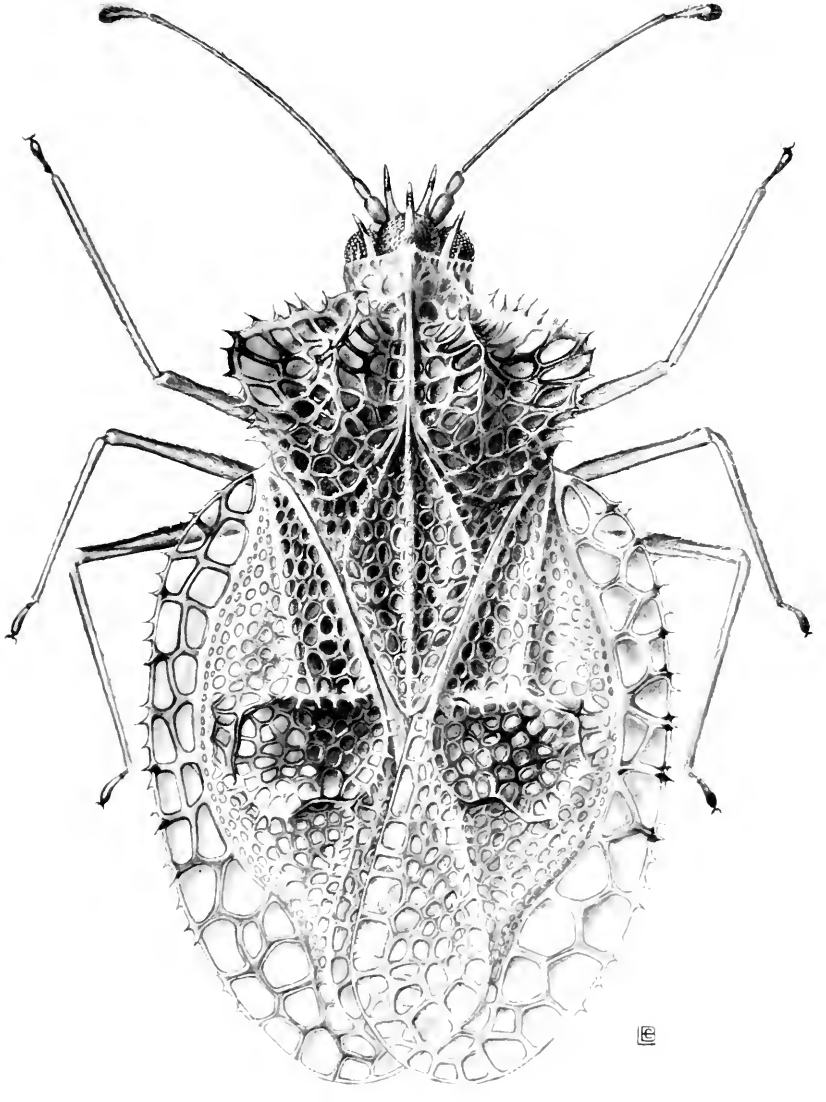


Fig. 2. *Dulinius unicolor* (Signoret).

Heer (1865) characterized a new fossil tingid as *Monanthia wollastoni* (p. 392), and labeled the figure on the preceding page as

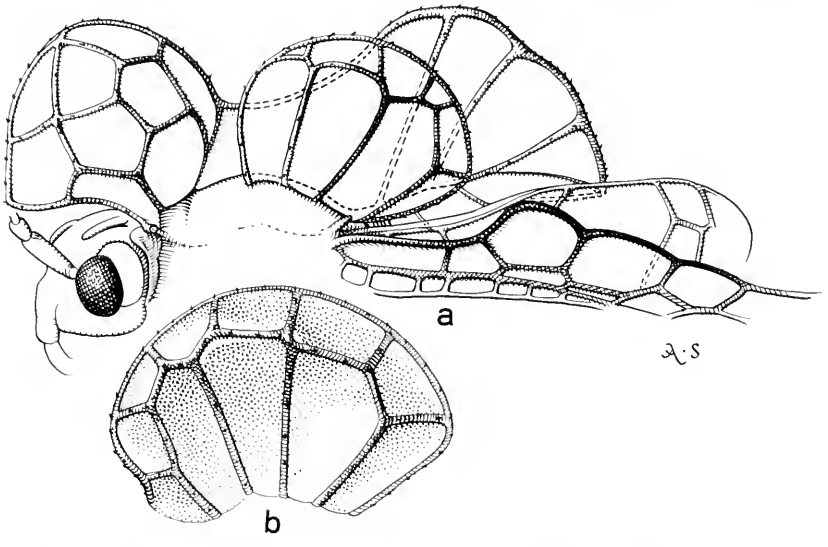


Fig. 3. *Dulinius unicolor* (Signoret) (*a*) lateral aspect of hood and pronotal carinae and (*b*) paranota, lateral aspect.

Tingis wollastoni (p. 391). Since this species is cited under the same trivial name in these genera, it is evident that Heer changed his generic conception of *wollastoni* while writing his paper and then failed to make the corresponding change in either the manuscript name above the description or in the caption under the illustration, perhaps the latter. As may be noted by the specific references cited above, Heer also failed to correct this error in subsequent publications, and likewise Scudder (1891) catalogues this fossil in two different genera under the same trivial name. The figure and description of *wollastoni* by Heer show that the species belongs to the genus *Oncochila* Stal, rather than to either *Tingis* Fabricius or *Dictyla* Stal (= *Monanthia* of authors, not Le Peletier and Serville) and thus it is here so transferred.

Dicrotingis, n. gen.

Fig. 4

Distinctly lacy, veinlets thin, areolae small. Head very short, slightly extended in front of the eyes, strongly declivent, armed with five spines, eyes moderately large, transverse, with hind margins in contact with pronotum; bucculae wide, areolate, closed in front. Labium passing prosternum; sternal laminae of rostral sulcus areolate, with ends forming a v-shape opening behind. Antenniferous tubercles very short, not spinelike, rounded in front. Antennae long, rather slender, first two segments slightly swollen, short, third seg-

ment very long and slender, fourth segment moderately long and fusiform. Hypocostal lamina long, narrow, uniseriate. Metathoracic

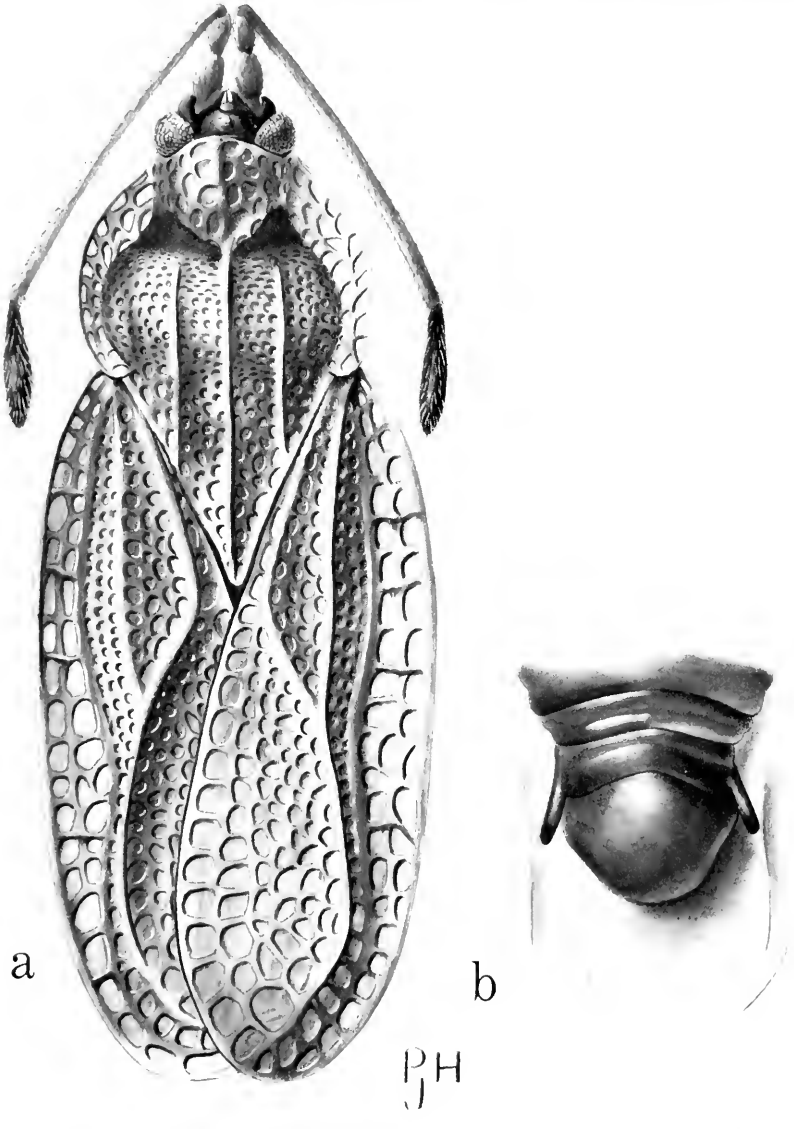


Fig. 4. *Dicrotingis digitalis* (Drake) ♂ (*a*) adult and (*b*) abdominal sternum VII (showing paired digital process) and genital segments.

scent glands with ostiole and ostiolar canal on each metapleuron, the sulcus nearly upright, its sides raised. Legs moderately long, slender,

Pronotum moderately convex, punctate, tricarinate; hood moderately large, inflated, feebly produced in front of collar, extending backwards between and slightly behind calli; hind margin triangularly prolonged backwards, areolate; paranota long, moderately wide, areolate, reflexed nearly upright. Elytra very little wider than abdomen, with sutural areas overlapping so that the apices lie jointly rounded at rest, divided into the usual areas, the discoidal area almost reaching to middle of elytra. Hind pair of wings present. Abdominal sterna clearly defined, the seventh sternum with a pair (one on each lateral side) of large teretial, divergent, posteriorly-directed, processes (fig. 4).

Type species, *Leptopharsa digitalis* Drake (1928) (fig. 4).

This genus is most closely allied to the genera *Leptopharsa* Stal and *Tingis* Fabricius, but it is easily separated from these other genera by the pair of hornedlike male processes (fig. 3) on the lateral sides seventh abdominal sternum. The female is unknown.

Diconoconis hewetti (Distant)

Elasmognathus hewetti Distant, 1908, Rec. Indian Mus., vol. 2, p. 127, pl. 7, figs. 2, 2a.

Elasmognathus picturatus Distant, 1909, Rec. Indian Mus., vol. 3, p. 165, figs. 4, 4a. (New synonymy).

Cysteochila picturatus Drake, 1937, Lingnan Sci. Jour., vol. 16, p. 386.

D. hewetti (Distant) and *D. picturatus* (Distant) were both described from specimens netted in Borneo (Kuching) by Hewett. An examination of the types (British Museum) show that the two names apply to the same species, the latter being represented by teneral specimens. *Hewitti*, named in honor of the collector, has priority by one year.

Stephanitis assamana subsp. *eremnoa*, n.n.

Stephanitis (*Stephanitis*) *assamana* subsp. *marginata* Drake and Maa, 1954, Quart. Journ. Taiwan Mus., vol. 7, p. 118.

Since *S. assamana* subsp. *marginata* Drake and Maa, is a homonym of *Tingis marginatus* Lamarck (1816) (= *Stephanitis marginata* (Lamarck) = *Stephanitis pyri* (Fabricius)), we are here proposing *eremnoa* as a new name for the subspecies *S. assamana marginata* Drake and Maa.

Agramma afrana, n.n.

Agramma angolana Drake, 1958, Comp. Diam. Angola, no. 38, p. 107, fig. 2.

Through oversight, *Agramma angolana* Drake is a homonym of *Serenthia angolana* Drake (1955). On this account, we are proposing the trivial name of *afrana* to replace *Agramma angolona* Drake (1958). The genus *Serenthia* Spinola (1837) is a synonym of *Agramma* Stephens (1829).

Stephanitis (*Menodora*) *kardia*, n. sp.

Fig. 5

Small, whitish testaceous, without color markings, appendages testaceous, body above and beneath brownish stramineous. Length

3.15 mm., width (across apex of pronotal process) 1.25 mm., (across widely separated apices of elytra) 2.12 mm.

Head very short, strongly declivent in front, concealed (except eyes) by the hood, armed with long, slender appressed or porrect spines; bucculae rather short, ends not meeting in front, widest behind, there four cells deep, slowly narrowed anteriorly to one row of cells. Labium pale, extending on metasternum; laminae of rostral

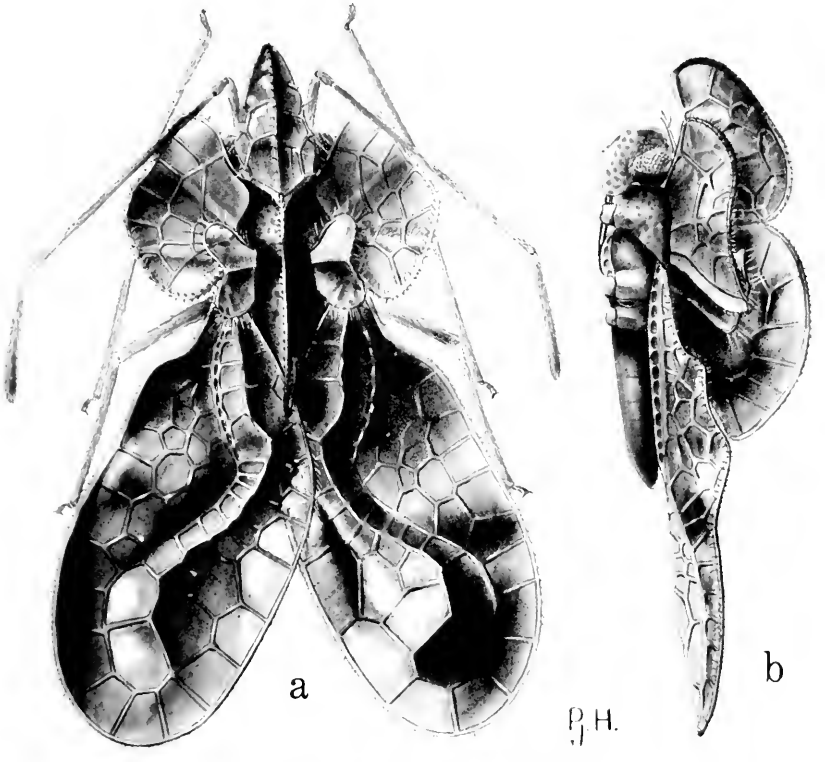


Fig. 5. *Stephanitis* (*Menodora*) *kardia* Drake and Ruhoff, (*a*) dorsal and (*b*) lateral aspects.

sulcus uniseriate, whitish, widely separated from each other. Antennae long, very slender, clothed with setal-like pubescence, with longer pubescent hairs on fourth segment, segmental measurements: I, 0.27 mm.; II, 0.10 mm.; III, 1.10 mm.; IV, 0.72 mm. Legs long, slender, pubescent. Hypocostal laminae moderately wide, uniserate. Metathoracic scent glands with ostiole and nearly upright, ostiolar sulcus on each metapleuron, with sides of sulcus elevated.

Pronotum slightly convex, finely punctate, tricarinate; lateral carinae short, very high, cordiform, composed of two cells; median carinae long, high, mostly two areolae deep, with upper margin con-

vex, longer than hood (72:64), at widest part almost as high as base of hood; hood moderately large, narrowed in front, extending considerably in front of apex of head, with dorsal surface curved downward anteriorly, basal length longer than great height (behind) (64:40), nearly twice as high as width at base; paranota very large, slightly reflexed, three areolae deep at middle (fig. 5); posterior projection of pronotum very long, narrow, tapering to an acute apex, extending backwards almost to apex of discoidal area of elytra. Elytra (fig. 5), strongly divergent posteriorly, with apices widely separated from each other; much longer and much wider than abdomen; costal area wide, four areolae deep in widest part beyond apex of discoidal area; subcostal area composed of one row of fairly large areolae, sloping gently downwards; discoidal area short, composed of one row of three or four areolae, only slightly inflated, with boundary vein between it and the subcostal area only slightly raised Outer margins on paranota and elytra finely serrate and beset with short hairs; median longitudinal vein of hood and median carina of pronotum also finely serrate. Superior and inferior surfaces of paranota and elytra with a few, scattered, fine, erect, long hairs. Veinlets thin, areolae moderately large, thus distinctly lacy in appearance.

Holotype (male) and *paratype* (male), (both macropterous), Singapore, C. F. Baker.

This species belongs to the subgenus *Menodora* Horváth of the genus *Stephanitis* Stal, which contains *formosa* Horváth of Taiwan and *sandika* Horváth of Java. *Kardia* can easily be separated from them by the distinctly heart-shaped, two-celled lateral carinae, scarcely inflated discoidal areas of elytra, and the narrow, long tapering hind pronotal process, which extends backwards almost to the apices of the discoidal areas of the elytra.

STUDIES IN DESERT SAND DUNE ORTHOPTERA

PART I. A NEW SPECIES OF *PLAGIOSTIRA* FROM EASTERN NEW MEXICO WITH KEY AND NOTES

Ernest R. Tinkham[1]

The discovery of a large and handsome new species of *Plagiostira* Scudder from the Mescalero Sands, 45 miles east of Roswell, New Mexico, and about 50 miles west of the Texas line, was made July 16-17, 1959, while the writer was conducting field investigations on the Desert Sand Dune Biota of the Great Chihuahuan Desert in the third summer of his three-year summer grant to study the Sand Dune Biotae of the North American Deserts under a National Science Foundation grant.

This article, Part I, will inaugurate a series of taxonomic papers with biological notes on the many new species of Sand Treader Camel Crickets (*Ammobaenetes*), sand dune acridids or grasshoppers and decticids or shield-backed katydids discovered during the course of the author's research into the Desert Sand Dune Biotae of the North American Deserts. These investigations were initiated in the spring of 1952 and carried on privately for five years until 1957. In that year the scope of the author's studies was greatly stimulated and expanded by the three-year summer grant from the National Science Foundation.

Upon receipt of this grant the spring and summer of 1957 was spent studying the Sand Dune Biota of the Great Sonoran Desert which includes the Colorado, Mohave, Gila, Sahuaro, Hermosillo and Gulf Coastal deserts. A similar period in 1958 was devoted to the Dune Biota of the Great Basin Desert of Nevada, Utah and northestern Arizona. During the spring and summer of 1959, the writer explored the widely scattered dune areas of the Great Chihuahuan Desert of eastern New Mexico, southwestern Texas and northeastern Mexico.

The Mescalero Sands of eastern New Mexico possess the richest Orthopteran fauna of all the numerous dune areas of the North American Deserts. Its general location is 35 to 45 miles east of Roswell on Highway 380 which traverses the dunes in its northern half. These dunes are nine miles across (E to W) in this area with a long axis (NE to SW) of at least 35 to 40 miles. As creosote (*Larrea divaricata*), marking the eastern edge of the Great Chihuahuan Desert, was observed east of the Pecos River and 17 miles west of the western edge of the Mescalero Sands, and as this margin angles southeasterly while the western edge of the Mescalero Sands angles southwesterly, it is believed that at its southwestern tip the Mescalero Sands are contiguous with the creosote margin of the Great Chihuahuan Desert. Thus, the Mescalero Sands can be said to lie on the very periphery of this great desert and its fauna, consequently, derived not only from the desert but also from the prairies to the east.

1. Indio, California

The Mescalero Sands are quite unusual as far as sand dunes are concerned for they are well covered with scrub oak which ranges from one to two feet in height. In places, bare sand dune ridges up to 20 feet in height are found, but for the most part the vast areas of these low-level dunes are semi-stabilized by scrub oak.

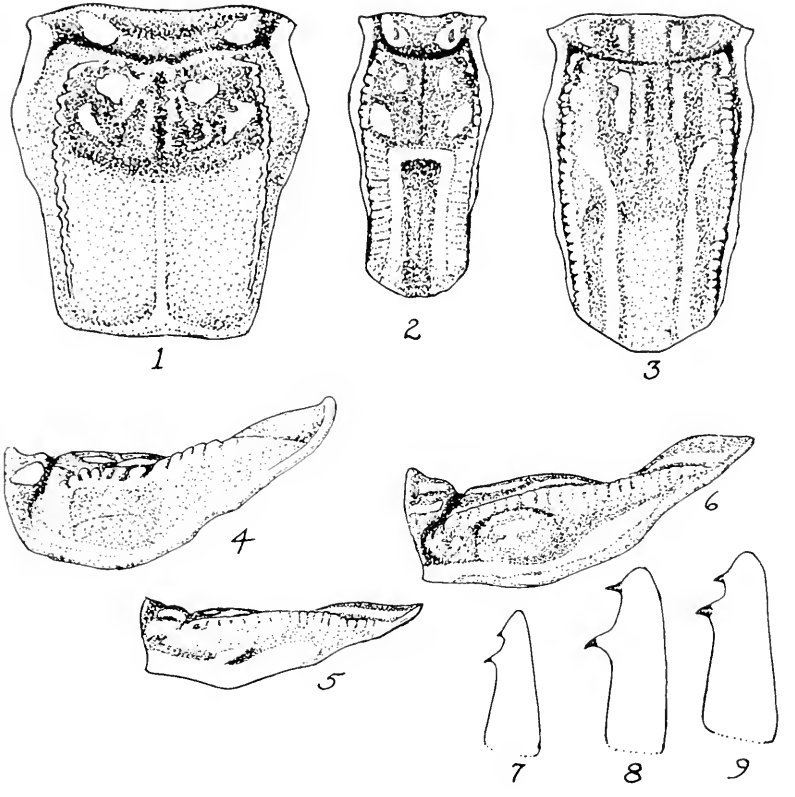
The Orthopteran fauna consists of at least 33 species taken on the two trips in July and September of 1959, thus attesting to its great richness.

PLAGIOSTIRA MESCALEROENSIS n. sp.

In size relationships, *Plagiostira mescaleroensis* is closest to *P. gillettei* Caudell 1907 from the Great Basin Desert, but in morphological features it is more closely allied to the much smaller *P. albonotata* Scudder 1876 of northern Arizona. The new species differs from *P. gillettei* by the following features: males slightly smaller and much more slender; fastigium more prominent and broader at the apex; metazonal streaks, so prominent in the new species, lacking in *gillettei;* dorsum of the pronotum narrower and longer than in *gillettei*; and in the female slenderer than in *gillettei* with color markings as in the male; abdominal markings more prominent and the ovipositor of about the same length as in *gillettei*. The new species of *Plagiostira* differs from *albonotata* by its much larger size, by the conformation of the markings on the disc of the pronotum (compare figures 2 and 3, 5 and 6) and by the shape of the pronotum when viewed from above and the side.

Description: typical of the genus. Male with the occiput rounding moderately into the fastigium which is as broad as the basal segment of the antennae above the scrobes, squarely truncate and broken at its base by a sulcus from the smooth curvature of the face. Head, above the clypeus, as broad as deep. Pronotum with a shallow sulcus just caudad of the truncate front margin, the lateral portions of this sulcus curving gently forward (see figures 3 and 4) to deeply notch the very prominent lateral margins of the pronotum which are hardly carinate but rather a rounded swollen boss with a crenulated appearance. This lateral rolled margin is parallel in its anterior half with maximum breadth at its middle, thence tapering or converging gently towards the posterior margin of the pronotum which is quite angularly rounded. Lateral lobes of the pronotum very shallow, the ventral margin gently bent at the posterior angle. Seen in profile and compared with *albonotata* (see figures 5 and 6) the anterior portion of the prozona and the posterior half of the metazona are much more strongly reflexed in the new species than in *albonotata* which has the plane of the pronotum almost flat. When similar comparisons are made with the new species and *gillettei* considerable differences are easily noted.

Tegmina with the front margin straight and about half the length of the pronotum when seen in lateral profile but only half its length as observed from above. Wings shining with smooth surface, jet black, completely covered by the tegmina with portions of the foremargin sometimes visible. Penultimate tergite of the abdomen



EXPLANATION OF PLATE

1. *Plagiostira gillettei.* Smith Valley, Lyon Co., Nevada. Dorsal view of male pronotum.
2. *Plagiostira albonotata.* Headquarters, Petrified Forest, Arizona. Dorsal view of male pronotum.
3. *Plagiostira mescaleroensis* n. sp. Mescalero Sands, Chaves Co., New Mexico. Dorsal view of Holotype male pronotum.
4. *Plagiostira gillettei.* Smith Valley, Lyon County, Nevada. Lateral view of male pronotum.
5. *Plagiostira albonotata.* Headquarters, Petrified Forest, Arizona. Lateral view of male pronotum.
6. *Plagiostira mescaleroensis* n. sp. Mescalero Sands, Chaves County, New Mexico. Lateral view of pronotum of Holotype male.
7. *Plagiostira albonotata.* Coral Pink Dunes, Kane County, Utah. Dorsal view of male cercus.
8. *Plagiostira mescaleroensis* n. sp. Mescalero Sands, Chaves County, New Mexico. Dorsal view of cercus of Paratype male.
9. *Plagiostira gillettei.* Smith Valley, Lyon County, Nevada. Dorsal view of male cercus.

considerably produced centrally with a deep median "U-shaped" notch, the lateral processes produced by this emargination rather acute. Subgenital plate with a narrow deep cleft, centrally. Cerci typical of the genus with one minute, almost apical tooth and another similar tooth situated just beyond the middle on the internal margin of the cercus. Caudal femora closely approximating the body length.

Leg Spination as follows: Fore femora with the internal inferior keel bearing 5-6 small, dark-tipped teeth; fore tibiae with 5-7 long, external, and 6 long internal teeth on the inforeior keels and 0 to 2 external dorsal teeth. Meso-femora with 4 internal teeth on the inferior keel (when leg is in forward position) and mesotibiae with 6-7 internal and 6 external long teeth on the inferior keels and two pairs of dorsal spines (below in folded leg). Caudal femora with 4-5 external and 5-6 internal teeth on the inferior keels. Caudal tibiae with 12-13 external, 14-15 internal, plus apical spines on the dorsal keels (below in folded leg) and 7 external and 6 internal teeth on the ventral keels (above in folded legs) plus the apical spines.

Living Coloration: Entire body foliage green with nacreous or silvery white markings located as follows: occiput with two longi-

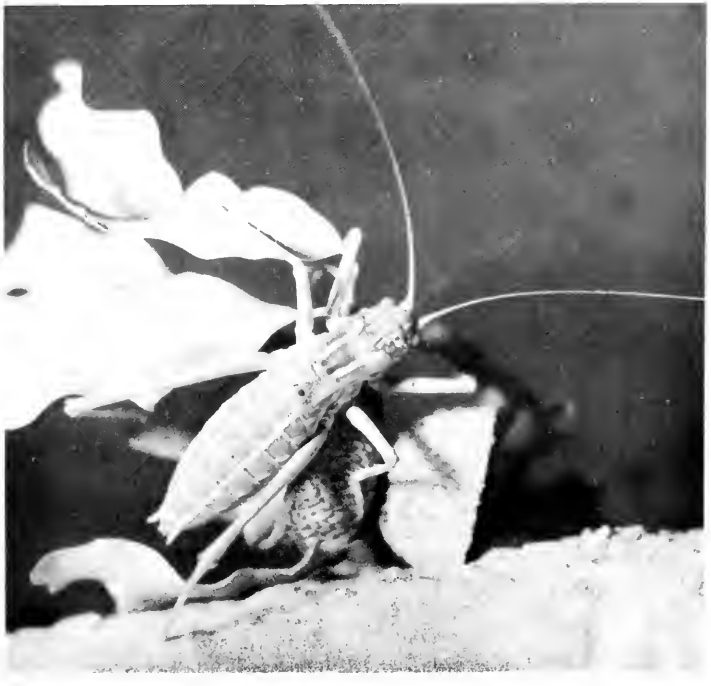


Fig. 10. Male *Plagiostira mescaleroensis* Tinkham n. sp. resting on scrub oak *Quercus harvardii* of its type locality. Photo illustrated pronotal and abdominal markings in living creature Ca 1.5 x.

tudinal stripes on either side of the dorsal line and a quadrate patch just caudad of the eye. A long broad band edging the lower margin of the eye carries irregularly forward onto the front of the face below the antennal scrobes. Another almost complete band extends from the posterior margin of the genae forward to cross the face except for a short break centrally above the clypeus. Pronotum above with silvery dashes (as illustrated in the figure 3) which are edged with vinaceous brown. The subocular cephalic strip extends caudally to form a broad band just above the interior margin of the lateral lobes of the pronotum. Centrally on these lateral lobes are suggestions of silvery areas (see figure 3). The rolled and crenulated lateral margins of the pronotum are a beautiful, clear, foliage green while the general tone of the pronotum dorsally is foliage green but paler laterally on the lobes of the pronotum.

Tegmina deep vinaceous brown with veins greenish or greenish white, the wing surface smooth and shining jet-black.

Abdomen with dorso-lateral white stripe with intrusions of same dorsally along the posterior margin of each segment and an oblique lateral stripe of silvery white as well as white along the lateral sternal fold. Legs foliage green in life. Thoracic sternites bearing the spines silvery white, remainder green; abdominal sternites green (see figure 10).

In death, colors vary according to the excellency of the preservation and the technique used. When perfectly preserved the colors closely approximate the living coloration but more often the greens fade to varying shades of brown even though the creature is well preserved.

Holotype Male: Mescalero Sands, Chaves County, New Mexico, 45 miles east of Roswell on Highway #380, night of July 16-17, 1959. Ernest R. Tinkham on *Quercus harvardii*. Measurements in millimeters made by Glogau callipers: Body length 26.4; length to apices of caudal femora 40.5; pronotum 11.0 x 6.5; lateral lobes of pronotum 4.0; caudal femora 24.3; caudal tibiae 25.2 mms. Holotype deposited in the Tinkham Eremological Collection.

Description of Female: features of the head, fastigium, pronotum, tegmina and legs as described in the male. Ovipositor straight, subgenital plate with a deeply rounded "V"-shaped notch. Coloration as in the male.

Leg Spination as follows: Fore femora with 5 small teeth on the internal inferior keel; foretibiae with 5 long paired teeth on the external and internal inferior keels and 3 dorsal (basal, median and apical) teeth on the dorsal surface. Meso-femora with 5 paired teeth on external and internal inferior keels plus the apical teeth and 2 pairs of dorsal teeth on internal and external faces. Caudal femora with 2-3 minute teeth on the external and 6 larger teeth on the internal inferior keels. Caudal tibiae with 13-15 external and 13-14 internal teeth on the dorsal keels plus the usual apical spine and 7 external and 6 internal teeth, plus an apical tooth, on the ventral keels.

Allotype Female: Same location as the male. Measurements in millimeters with Glogau callipers: body length 28.0; body length to apex of caudal femur 40.8, length to apex of ovipositor 55.7; ovipositor 30.0; pronotum 12.0 x 6.2; depth of lateral lobes of pronotum 3.8; caudal femora 25.5 and caudal tibiae 26.2 mms. Allotype Female deposited in the Tinkham Eremological Collection.

Paratype Males: 4, same data as the types. Range in measurements in millimeters: Body length 25.2 to 30.0; pronotum 10.8 x 6.3 x 4.0 to 11.2 x 7.6 x 4.0; caudal femora 23.5 to 25.2, caudal tibiae 25.2 to 26.8 mms. Paratypes similar to the Holotype in every respect.

Paratype Females: 7, same data as the Types. Range in measurements in millimeters: body length 28.5 to 31.5; length to apex of oviposter 57.5 to 61.0; oviposter 29.2 to 31.4; pronotum 10.6 x 6.5 x 4.0 to 11.0 x 6.5 x 4.0; caudal femora 25.8 to 25.0; caudal tibiae 25.4 to 27.0 mms. Paratypes similar to the Allotype female in every respect, except that in four of the six paratypes the oviposters show a very slight decurvature. Paratypes will be deposited in the major Orthopterological Museums of this country.

Biological Notes: At 9:00 p.m. July 16, 1959, shortly after my arrival at the eastern edge of the Mescalero sands, I found the first female of *P. mescaleroensis* ovipositing in a small area of bare sand which was surrounded by scrub oak one to two feet high. The temperature was: air 25.0° C. and the sand surface 25.5° C.; its surface dry for one quarter of an inch and damp below that. A breeze was freshening as a black thundercloud was growing in the northwest with frequent flashings of lightning.

The song of the male trilling in the scrub oak was a "zee-zee-zee-zee-zee-zee—" long continued. Two males were located.

The Mescalero Sands were ringing with katydid songs. I heard the song of *Rehnia* but my evening's work, barely begun, was suddenly terminated about 10:00 p.m. by the arrival of a blast of very cold air which quickly silenced all katydid sounds and had me running for the car as a downpour struck. The drizzle continued most of the night and as it was beginning to lighten in the east I drove east again to my collecting spot long before the sun appeared. Most of the *Plagiostira* material came from several, cone-shaped, scrub-oak hummocks about ten feet high. Here, in the early dawn, I observed a female *Plagiostira* catch a *Melanoplus glaucipes* which, after some violent struggling, managed to escape by leaving a hind leg in the mouth of its would-be captor.

The orthopteran fauna was the richest ever observed on any sand dune area of the vast expanse of the North American Deserts, comprising a total of 33 species taken on two visits in mid-July and mid-September of 1959. There were four species of Decticids, the new *Plagiostira* with *Rehnia cerberus* in the few isolated mesquite clumps and *Pediodectes haldmanii* and *P. stevensonii* common in the denser scrub oak thickets, and these apparently preyed upon the abundant acridid life which showered out of the scrub oak. There were several species of *Melonaplus* and one *Schistocerca*, as well as quite a few

oedipodines and acridines, Phasmids, Mantids, phanerotropids and stenoplematids on the sands at night. At 6:45 a.m. the temperature had warmed to 18° C. for the air and wet sand surface. It had probably cooled to 12 or 14° C. during the wet hours of the night.

Plagiostira mescaleroensis was more restricted in habitat and numbers than the other three decticids. On my second trip, September 12-14, I could not find a single *Plagiostira* by long and diligent searching over the type locality, although *P. haldmanii* and *P. stevensonii* were still common and *R. cerberus* still inhabited the same mesquite clumps as in July.

Egg: One female contained 80 perfectly developed ova which like those of all Decticids exhibit a shining, pale, pearly pink chorion. The length, measured under the binocular microscope was 6.2 mms. long x 1.9 mms in breadth. The outline, typical of all Decticid eggs, was much the shape of acridid eggs, elongate, narrowly elliptical with well rounded ends. The chorionic sculpturation exhibits under the reflected light of the microscope, minute hexagonal cells, covered completely with this pearly pink covering material except in the center where each cell is pierced by a variably sized circular opening. Only at the cap end and along the margin of the cap is the true nature of these cells revealed. Here some small areas were not covered with the pearly pink chorionic material and only the cell walls remained, thus revealing their hexagonal form.

Nymphs: Due to the high elevation of these dunes, around 4500 feet elevation, and the very cold winters in this section of eastern New Mexico, it is almost certain that the eggs hatch in midspring and by late June or early July, these nymphs have reached maturity. No nymphs were found on July 16-17, 1959.

KEY TO THE GENUS *PLAGIOSTIRA* SCUDDER

1. Size large, length of pronotum about one and one-half times its dorsal breadth. No nacreous markings on the metazona. Eastern Utah and western Nevada ..... *gillettei*
   Size medium-large to small. Nacreous markings on the metazona as well as the prozona of the pronotum 2
2. Size medium-large. Pronotum in profile distinctly subsellate. Nacreous markings on the prozona consisting of two short parallel streaks and with 2 long parallel streaks on the metazona, the cephalic apices of which flare outwardly. Eastern New Mexico ..... *mescaleroensis n. sp.*
   Size small. Pronotum in profile almost flat. Pronotal length more than twice the pronotal breadth. Prozona with two pairs of nacreous spots and metazona with an inverted, white, straight-bottomed "U" shaped design. Northern Arizona east to the Rio Grande in New Mexico ..... *albonotata*

PLAGIOSTIRA GILLETTEI Caudell 1907

This very large and distinct species exhibits a discontinuous distribution being found in western Nevada and also southeastern Utah.

The Nevada specimens, taken by Tinkham, came from the Sand Springs Dunes, a mountainous ridge of sand, 28 miles east of Fallon, Nevada. Here, a few specimens were taken the night of June 23-24,

1958. On June 24, about 11 a.m. one female, with one missing hind leg, lay dying on the hot sands which were 49.5° C. The host plant was *Tetradymia comosa*. Dr. Ira LaRivers obtained a goodly series the night of July 21, 1949, on Nevada Highway #3, between Central and Wilson Canyons, Smith Valley, Lyon County, Nevada. This was a very good year, the best in the past two decades as far as moisture was concerned. In this section of its distribution, *P. gillettei* is a member of the fauna of what the writer calls the Lahontan Desert, one of three eremological components of the Great Basin Desert; the other two being the Great Salt Lake Desert and the third, the San Raphael Desert of southeastern Utah. The Great Salt Lake Desert appears to separate the distribution of *P. gillettei* into two distinct portions. Nevada specimens exhibit the nacreous markings as portrayed in the drawing.

In the eastern section of its range, *P. gillettei* is a member of the San Raphael Desert fauna. Specimens from this desert show little or no white markings on the prozona of the pronotum, but there seems to be no criterion worthy of racial separation between the Nevada and Utah specimens. My specimens came from the Cane Spring Dunes, 19 miles north of Hanksville, Utah, where on the night of August 3-4, 1958, they were found on a species of *Chenopodium*. A few nights later, one dwarf male, was taken, the night of August 5-6, 1958, on rabbit brush (*Chrysothamnus* sp.) on the Coral Pink Dunes. These dunes lies in the Pine Zone at a high elevation (6000-6500 feet) and the cold nights probably account for the dwarf male. One other specimen before me, a male, was taken by Dr. Vasco M. Tanner, at Willow Tanks, Kane County, in the so-called Escalante Desert, Utah, June, 1936. The type male (Cat. No. 10188,USNM) was described from Grand Junction, Colorado and collected by C. P. Gillette, June 20, 1905. Thus we see there are no specimens of the Utah species found west of the great Wasatch masiff. *P. gillettei* has not yet been taken in Arizona, although the Coral Pink Dunes specimen is only about 10 miles north of the Arizona boundary. These dunes are 3 miles SE and 10 miles SW of Mt. Carmel Junction, Utah.

PLAGIOSTIRA ALBONOTATA Scudder 1876

This small species is found principally in the so-called Painted Desert region of Arizona, whose fauna is closely allied, if not similar to that of the San Raphael Desert. The writer has taken it in the Winslow area and at the headquarters of the Petrified Forest on rabbit brush. It ranges west to invade the eastern edge of the Western Pine Zone, some ten miles east of Flagstaff, Arizona. Eastward it has been recorded as far as Albuquerque, New Mexico, and southeastward to Pindale (correct Pinedale) which is 15 miles west of Showlow, Arizona. The writer took one pair of large size at the Mittens area of Monument valley the night of August, 1958, on a plant related to Sheppard's Purse, growing in a patch of deep red sand. Another male was taken the night of August 5-6, in the *Artemesia tridentata* zone edging the Coral Pink Dunes. These three specimens

may be the first Utah records. Caudell in 1907, also reported the species from Dolores and Durango, Colorado.

PLAGIOSTIRA MESCALEROENSIS n. sp.

This beautiful and large new species is known only from a small area of oak covered sand dunes, the Mescalero Sands, about 45 miles east of Roswell, New Mexico. It is a member of the Pecos Desert fauna, one of three eremological components of the Great Chihuahuan Desert, the other two being the Coahuila Desert of the Big Bend region and northeastern Mexico and the Salado Desert of eastern Zacatecas and western Nuevo Leon.

REFERENCES

Caudell, A. N.
1907. The Decticinae (A Group of Orthoptera) of North America. Proc. U. S. Nat. Mus. 32:285-410, 94 figs.

LaRivers, Ira
1951. New Nevada Orthoptera Records for the 1949 Collecting Season. Pan-Pac. Ent., 27(4):173-180.

Tinkham, Ernest R.
1944. Biological, Taxonomic and Faunistic Studies on the Shield-Back Katydids of the North American Deserts. Amer. Midland Nat., 31(2)257-328, 28 figs.

Onion Maggot in Provo Area

The onion maggot, *Hylemya antiqua* (Meigen), has been found in two small onion patches in Provo this spring. On June 7th several medium sized bulbs which were heavily attacked by maggots were placed in breeding cages. The first adults emerged on June 23. Pupa and other adults were collected on June 27. The onions from the infested gardens came from a local seed company. Bulbs or sets and small green onions in bunches of 100 are sold for replanting. This may account for spread of the infestation.

This Anthomyiidae is not common in this area. Some of the large onion producers report that during wet season they are bothered by this Diptera.

—Vasco M. Tanner

500 8-60 PRUP 16068

The Great Basin NATURALIST

VOLUME XX November 30, 1960 Nos. 3 & 4

TABLE OF CONTENTS

PUBLISHED BY
BRIGHAM YOUNG UNIVERSITY

The Great Basin Naturalist

A journal published fron one to four times a year by Brigham Young University, Provo, Utah

MANUSCRIPTS: Only original unpublished manuscripts, pertaining to the Great Basin and the Western United States in the main, will be accepted. Manuscripts are subject to the approval of the editor.

ILLUSTRATIONS: All illustrations should be made with a view to having them appear within the limits of the printed page. The illustrations that form a part of an article should accompany the manuscript. All half-tones or zinc etchings to appear in this journal are to be made under the supervision of the editor, and the cost of the cuts is to be borne by the contributor.

REPRINTS: No reprints are furnished free of charge. A price list for reprints and an order form is sent with the proof.

SUBSCRIPTIONS: The annual subscription is $2.50, (outside the United States $3.25). Single number, 80 cents.

All correspondence dealing with manuscripts, subscriptions, reprints and other business matters should be addressed to the Editor, Vasco M. Tanner, Great Basin Naturalist, Brigham Young University, Provo, Utah.

REPRINTS SCHEDULE OF THE GREAT BASIN NATURALIST

	2 pp.	4 pp.	6 pp.	8 pp.	10 pp.	12 pp.	Each Additional 2 pp.
50 copies	$6.00	$7.00	$8.00	$9.00	$10.00	$11.00	$2.00
100 copies	7.00	8.00	9.00	10.00	11.00	12.00	
200 copies	8.00	9.00	10.00	11.00	12.00	13.00	
300 copies	9.00	10.00	11.00	12.00	13.00	14.00	

COVERS: $10.00 for first 100 copies. $4.00 for additional 100 copies.

The Great Basin Naturalist

Published at Provo, Utah by
Brigham Young University

Volume XX | November 30, 1960 | Nos. 3 & 4

STUDIES IN NEARCTIC DESERT SAND DUNE ORTHOPTERA PART II. TWO NEW GRASSHOPPERS OF THE GENUS *TRIMEROTROPIS* FROM THE UTAH DESERTS

Ernest R. Tinkham[1]

This, the second part of the author's new series of studies on Nearctic Sand Dune Orthopterans, reports on a large, arenicolous grasshopper inhabiting the sand dune areas of the San Rafael Desert of southeastern Utah and a very distinctive but smaller race dwelling on the sand dunes of western Utah in the Great Salt Lake Desert, both deserts being eremological components of the Great Basin Desert.

In 1932, just before my departure for Lingnan University, Canton, China, Miss Grace Olive Wiley, who lost her life in late July of 1948 from the bite of an Indian cobra, presented to me two females and a male of a very large *Trimerotropis* that she had collected in Emery County, Utah, on July 21, 1921. For many years these three specimens have reposed in my collection awaiting the time when I might have the chance to study this handsome race in the field and obtain additional materials for the type series. That opportunity came in 1958, in the second summer of my three-year summer grant with the National Science Foundation, while exploring and studying the dune biota of the Great Basin Desert.

On Sunday evening, August 3, 1958, as the sun was setting, I found a small drift sand area just north of where Utah Highway No. 24 crosses the San Rafael River, some 33 miles north of Hanksville and 5 miles west and 22 miles south of Green River. A few minutes later while scouting around, I flushed a very large reddish grasshopper with bright yellow wings heavily banded with black. I finally captured the wary creature after much stalking and chase. On examinatoin, I realized immediately that at last I had found the habitation of Miss Wiley's specimens.

By dark, I had collected a small series of this new race. The most interesting feature that I discovered in the chase was that the female made a loud cracking whir when alighting and that the male produced only a faint whir at the most. In most Oedipodine acridids producing sounds in wing flight, it is the male that makes the loud

1. Indio, California.

rippling or crackling sounds while the females produce only a slight sound or are mute.

In this new race both females and males could fly silently when pursued. When flying unpursued or undisturbed, the female when alighting produced the loud crackling sound, announcing her arrival to any male or males in the immediate vicinity. The purpose of her performance certainly produced the desired effect, for as she was alighting with loud rippling song, the male or males in the area flew up and towards her on shortflight to quickly settle or if nearer her hopped quickly in her direction. When, however, they were 12 to 18 inches away from her, they slowed down their walking speed and approached with more caution. Life for such females appeared to be a very lively one with so many suitors responding to her call.

The females and males were very wary and I pursued one quite some time back and forth across the highway. Many of the escape flights were quite long, up to fifty yards or more. All the females observed produced the most sound when settling down, the male practically none or at most a faintly audible whir.

After dark, Jimmy Brister, the high school lad with me, and I collected some hours by Coleman lantern, then journeyed southward in search of the Cane Spring Dunes. About midnight, in the light of the car, large drift dunes showed up on the very edge of the road where the pavement ended. Here we camped some 19 miles north of Hanksville, Utah. I collected until 2 a.m. and found three of the hoppers by lantern light, perched for the night in dune vegetation.

Next morning, the dunes were very hot and the hoppers wily. By dint of considerable effort and much perspiration I obtained a nice series here of the handsome race. My field notes recorded their habits during the hot morning similar to those of the late evening before. When a female alighted with loud clatter any males nearby flew a short distance towards her, then stopped to walk rapidly in her direction, then stopped again and approached more cautiously the last short interval of several inches. Apparently the sight of her big yellow wings with heavy black bands and loud rippling wings was enough to charm all males of her kind within considerable distance of her.

It is an honor to name, I regret posthumously, this very large and attractive dune grasshopper after its discoverer, Miss Grace Olive Wiley, who as a young woman before beginning her amazing and dangerous career as a noted herpetologist, started out her professional life as an entomologist.

Trimerotropis agrestis gracewileyae, n. subsp.

The sand dune grasshoppers of the *agrestis-citrina* complex inhabiting southeastern Utah and eastern New Mexico (Mescalero Sands) so closely approximate each other in their morphological features that their separation into species groups is most difficultly accomplished. Although I had considered this new race as a variety of *agrestis* for many years, the discovery, in 1959, of another *Trimero-*

tropis on the Mescalero Sands which was similar in size, coloration and taxonomic features, cast some doubt as to its specific origin. Finally, after much study, I discovered that the only clue of value to their group origin lay in the coloration of the inner face of the caudal femora. In the *agrestis* group this face is a uniform coral red, in the *citrina* group the coloration shade is a slightly deeper red, not enough to differentiate in itself, but there was in addition, two black patches on the inner face of the caudal femora which were diacritical. Of these, the proximal one is the largest and almost centrally placed while the smaller distal patch is located about the apical three-quarters.

Having resolved the species-group complex in this most difficult Acridoid genus, further characterization of the new and magnificent variety, becomes much simplified.

Compared with typical *agrestis* from the type region of Nebraska, *gracewileyae* is one and one-half times larger in size. Whereas, typical *agrestis* has the lateral lobes of the pronotum of the same breadth throughout, even though the lower margin is at an oblique angle, the new Utah race has the lateral lobes actually broadest just above the enlarged posterior angle of the lateral lobes of the pronotum. In the new race, the depression of the fastigium and frontal costa is more prominently enhanced by the raising of the carinae edging the fastigium, the foveolae of the vertex and the frontal costa. The male of *gracewileyae* is considerably larger than the females of *agrestis* from Nebraska and the antennae appear exceptionally long.

The new race of *agrestis* is the largest *Trimerotropis* known, with the possible exception of *T. magnifica* Rehn, and cannot be confused with *agrestis* east of the Continental Divide. When once separated by the characters presented above, as well as others, from a new race of *citrina* soon to be described from the Mescalero Sands, *gracewileyae* cannot be confused with any other species of the genus *Trimerotropis* by reason of: its very large size, uniform reddish body coloration, isabelline and non-fasciated tegmina, and by the unspotted coral red coloration of the inner face of the caudal femora which, in many species of *Trimerotropis*, bears bands on that inner face similar to the fasciation observed on the outer face of the caudal femora.

Description: Male: Head with fastigium distinctly sunken between the well defined lateral carinae which commence, caudally, on the occiput where the inner margins of the compound eyes are narrowest apart, the carinae diverging slightly to the posterior portions of the lateral foveolae of the vertex, thence converging in straight lines to a position immediately above the median ocellus. From here they expand again around the median ocellus to continue diverging, moderately, to the clypeal margin. Frontal costa quite deeply sulcate throughout. Antennae very long slender, extending to the basal quarter of the caudal femora. Foveolae of the vertex well defined by carinae on their anterior margins, open behind.

Pronotum with the median carina low but distinct throughout, the prozona notched by two sulci forming two rounded lobes (when viewed in profile), the anterior lobe twice the length of the posterior

one. A trace of a lateral carina is discernible on the anterior lobe of the prozona and there is a well-defined low lateral carina on the anterior two-fifths of the metazona. The posterior margin of the dorsum of the pronotum is right-angular, the angle moderately rounded. Lateral lobes of the pronotum deep, the posterior margin diverging slightly ventrally so that the greatest breadth of the lateral lobes is just above the enlarged posterior angle. The inferior margin, due to the enlargement of the posterior angle, is quite obliquely angled. The posterior angle bears a large downward projecting tooth which has caused the lower margin to be oblique and the posterior margin to be broadest just above the posterior angle. Tegmina long and narrow, the apices extending for five-sixths the length of the caudal femora beyond the apices of the caudal femora.

Coloration: generally pale mottled reddish brown; the tegmina pale dull reddish in ground color with the veins of the cells straw-colored and the anal area (the ridge area in the closed tegmina) streaked with straw coloration. The tegmina bear isolated, small brownish blotches, but these do not coalesce sufficiently anywhere to indicate any type of fasciation. Caudal femora with lower face straw-colored, inner face entirely coral red without any trace of blackish areas. Caudal tibiae coral red on the inner face, pale whitish pink on the basal half exteriorly with coral red in the apical exterior half.

Wing 31.0 mm. across, wing disc pale yellow (11 mm. broad) with a broad black band 10 mm. wide which is almost as broad as the disc. Band curves through the center of the wing; apical portions beyond the band, hyaline with the veins in its central portion black, elsewhere pale yellow. The cubitus vein is yellow throughout, thus separating its anterior portion into a small costal area.

Holotype Male: Cane Springs Dunes, 19 miles north of Hanksville, Emery County, Utah, August 4, 1958, Ernest R. Tinkham. Measurements in millimeters with Glogau calipers: total length to apices of tegmina 40.9; body length 30.0; length to apices of caudal femora 27.8, pronotum 6.1 x 5.0; lateral lobes of pronotum measured from metazonal lateral carina to apex of tooth at the posterior angle 5.5 x 4.1 maximum breadth just above this tooth; caudal femur 16.7 mm. Holotype deposited in the Tinkham Eremological Collection.

Description: Female: Female closely similar to the male in all morphological features with the variations as noted here: pronotum with the lateral carinae on the fore portions of the prozona and the metazona slightly more prominent than in the male, otherwise the characters appear identical other than the usual heavier build characteristic of all females.

Wing similar to the male, total length 37.0 mm., the black band 11.5 mm. broad, the disc 13.5 mm. General tone of the disc a shade paler yellow than in the male. Spur, as in the male, very short and blunt, less than ⅓ the breadth of the disc.

Ovipositor typical of the genus *Trimerotropis*.

Allotype Female: same locality as the Holotype. Caliper meas-

urements as follows: total length 49.5; body length 38.5; length to apex of caudal femur 35.5; pronotum 8.6 x 6.1; lateral lobes of the pronotum 6.7 x 5.2 wide; caudal femur 20.0 mm. Allotype deposited in the Tinkham Eremological Collection.

Paratype Males: Identical to the Holotype in every respect. Eleven males from the following locations: 5 Paratype males from the type locality; 4 from the sand dunes 33 miles north of Hanksville and just north of the San Rafael River; 1 male from Moab Dunes, 16 miles NW of Moab, 2-3 August, 1958; all collected by Ernest R. Tinkham. One male Paratype from Emery County, 21 July, 1921, Grace Olive Wiley. Range in measurements in millimeters: total length 37.0—42.2; length to apex of caudal femur 27.5—30.5; body length 27.0—30.5; pronotum 5.5—6.3 x 4.9-5.7 in breadth. Paratypes to be deposited in the following collections: Academy of Natural Sciences of Philadelphia; Brigham Young University, Los Angeles County Museum, University of Michigan and United States National Museum, and Tinkham Collection.

Paratype Females: Identical to the Allotype Female in every respect. 22 Female Paratypes from the following locations: 10 from the Type Locality; 9 from the sand dune areas 33 miles north of Hanksville; 1 from Moab Dunes all collected by Ernest R. Tinkham. 2 female Paratypes from Emery County, July 21, 1921, Grace Olive Wiley.

Range in millimeters: Total length to apices of caudal tegmina 44.5—49.5; length to apices of caudal femora 33.8—25.2; length to apex of ovipositor 34.9—37.4; pronotum 6.5—7.0 x 6.2—7.0 in breadth; lateral lobes of the pronotum 7.2—7.2 x 5.2—4.8 mm. Distribution of Paratypes as indicated above.

T. a. gracewileyae represents the optimum development of the species on the hot sand dune areas of the San Rafael Desert of southeastern Utah.

In addition to the type series there is in the Tinkham Eremological Collection considerable atypical material of *gracewileyae* originating in more distant sand dune areas. These areas are found in southwestern Utah, in the Navajo country of northern Arizona and extreme northwestern New Mexico. They lie at higher elevations within the Pinyon-Juniper Zone or the Pine Zone where cooler temperatures and colder nights prevail.

Specimens of *T. agrestis* from these dune areas are much the same size as typical *T. agrestis* from Nebraska but such morphological features as the deeper sulcation of the frontal costa and the deep and ventrally expanded lateral lobes of the pronotum, coloration and other additional features, indicate *gracewileyae* rather than *agrestis* is represented. However, due to their much smaller size they cannot be considered typical *gracewileyae* which as already stated is, with the exception of *magnifica*, the largest species of the genus.

These atypical *gracewileyae* come from the following locations: Utah: Coral Pink Dunes, Kane County, elevation 6000-6500 in the

Pine Zone, August 4-5, 1958, Ernest R. Tinkham, 8 males, 25 females, 1 female nymph. Arizona: Kayenta Dunes, 1 mile north of Kayenta, Navajo County, August 1, 1958, Ernest R. Tinkham, 15 males, 8 females. Tonalea Dunes, Conconino County, August 1, 1958, 1 male. These are the first Arizona records. New Mexico: sand areas along the San Juan River at Shiprock, San Juan County, July 23, 1948, Ernest R. Tinkham, 1 female. Small sand patch in Pine Zone, 5 miles east of Window Rock, McKinley County, July 22, 1948, Ernest R. Tinkham, 1 female.

In a 1959 publication I have reported on the self-burial habits of *T. agrestis* observed on the Coral Pink Dunes. This species and *Coniana snowi* are the only two Nearctic acridids, known to date, exhibiting self-burial habits. Self-burial habits in acridids of the Mediterranean and Ethiopian Faunal Regions are much better known and have been the subject of much study by Old World Orthopterists. Perhaps it is the cold nights that induce self-burial habits in certain arenicolous acridids. Nights on the brick-red sands of the Coral Pink Dunes, high in the Pine Zone just east of Zion National Park, are much colder than those on the Cane Spring Dunes of the San Rafael Desert and undoubtedly accounts for the absence of such self-burial traits in typical *gracewileyae*. Those interested for a full account of this interesting phenomenon are referred to the recently published article.

On the Coral Pink Dunes, I found atypical *gracewileyae* very abundant, showering out of the green patches of a legume *Psoralea stenostachys* Rydberg that were growing in the deep depressions surrounded by high dunes. In these depressions their heavy black-banded yellow wings made a colorful show. At dusk they congregated on the sands under these legume plants but later that night, by lantern light, I found them resting in the leafy tops of these foot high leguminous plants. Counts made at night revealed 6 to 10 of these hoppers per square yard in these green patches of legume. Out on the bare sand dunes very few hoppers ever spent the night. Those that did kicked holes in the sand with their caudal tibiae and rested in these depressions for protection during the cold night.

Trimerotropis agrestis barnumi n. subsp.

In 1958, I collected some small nymphs of *T. agrestis* on June 15 from low dunes 2 miles NW of Flowell, Millard County, Utah, and by feeding these emerged into imperfect adults some weeks later. As they indicated a new race, efforts were made in July, 1960, to obtain a goodly series, and such was found at the Oak City Dunes, July 26. These dunes lie about 3 miles WSW of Oak City and are traversed by Utah Highway No. 125 going west to Delta. Where scurf pea *Psoralea* carpeted the low dunes the new race was quite abundant, as many as several per sq. yd., but where the sand was bare and *Psoralea* absent so was this hopper. They had the habit of flying only a few feet, the males with rather a loud buzzing sound,

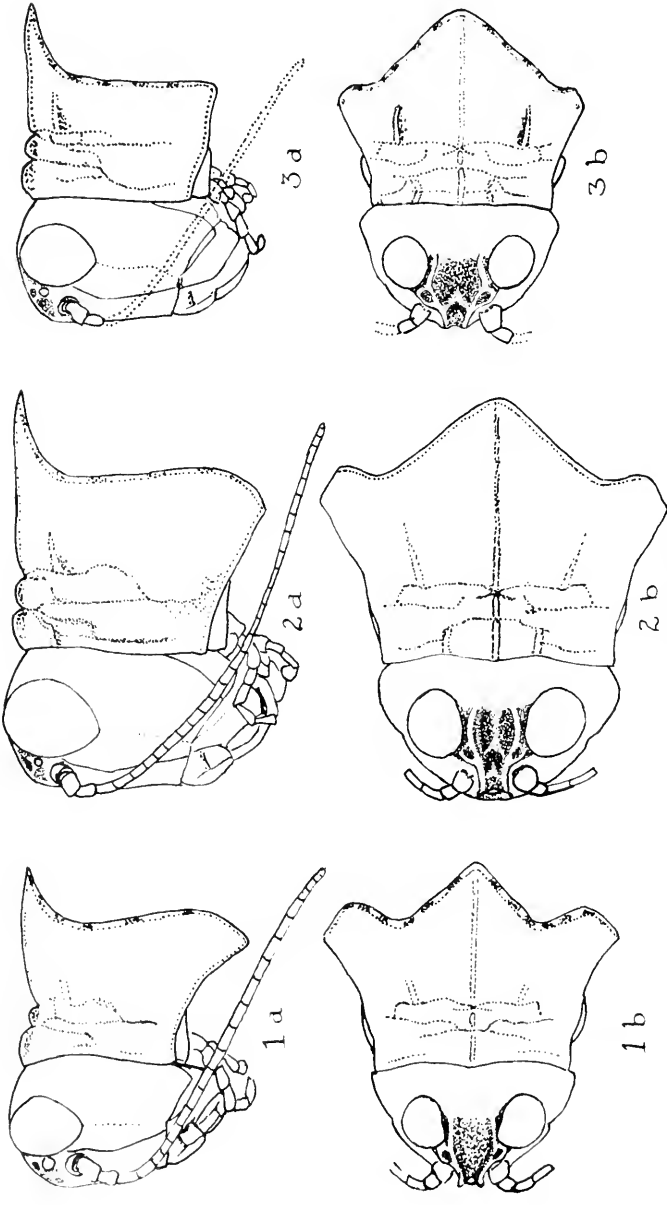
the females with a low distinct whir, on short rapid flights but as the sand was 58.0°C. at 10:15 a.m., July 26, they did not long remain on the sand but within a few minutes crawled or hopped for the nearest shade under the scurf peas. Several hours later at the Hawbush Dunes, 10 miles north of Flowell on the road to Delta, when the sand was over 60.0°C. they immediately hopped off the sand into or on top of the scurf peas. At this time they were much more wary and flew greater distances than those at the Oak City Dunes.

Description: Male: Slightly larger than the nominal race but considerably smaller than *T. a. gracewileyae* of the San Rafael Desert. Differs from *T. a. agrestis* and *T. a. gracewileyae* by the greater expansion and prolongation downwards of the posterior lateral lobe of the pronotum, the apex of which is reflexed outward and quickly discernible to the unaided eye when viewed from above (compare figures a and b of 1, 2, and 3). Additional distinguishing features are found in the fastigium, the lateral foveolae, the frontal costa, size of the eyes, the lateral profile of head and pronotum, the lateral carinae on the shoulders of the metazona and perhaps other features as well. The posterior extremity of the dorsum of the metazona is exactly right-angled and acutely rounded whereas in *agrestis and gracewileyae* this angle is slightly obtuse (approx. 100°) and the apex well rounded (compare b figures). However, the diacritical feature is the enormous prolongation downward of the lateral lobe of the pronotum which will distinguish *barnumi* from all other Nearctic species of *Trimerotropis*.

Description: Head conformation typical of the genus with eyes sub-globose, their vertical depth very slightly greater than the genal groove, their breadth slightly less than their depth. Fastigium of the vertex concavely sunken throughout, margined by well defined lateral carinae which are percurrent with the lateral margins of the frontal costa. The lateral carinae of the fastigium commence centrally between the compound eyes, diverging gently to the lateral foveolae of the vertex, where, at the anterior margin of the eyes, they converge rather strongly in a straight line to the point of stricture with the frontal costa just above the antennal bases where they again expand around the median ocellus to continue diverging gently to almost the clypeal margin where they evanesce. At the stricture above the median ocellus their separation is slightly less than half the breadth of the fastigium of the vertex. In lateral profile the dorsal margin of the compound eyes slightly crests the ridge of the fastigial carinae, the fastigium rounds evenly into the frontal costa. Lateral foveolae small, lateral, narrow, and not as broad and discernible as in *T. a. agrestis* or *T. a. gracewileyae*.

Pronotum broad, somewhat compressed or squattish, rather short in length with the lateral lobe margins divergent ventradly, the posterior angle especially with the huge lobes somewhat reflexed outwardly—this character being the chief diacritical feature of the new race *barnumi*. The median transverse sulcus crosses the anterior third, the metazona flat with a bare line of median carina; the pro-

zona gently raised into two rounded lobes, the anterior of which is slightly the highest and twice the length of the smaller posterior one. Metazona angular at the shoulders but with little evidence of carinae



Explanation of Plate

1 a. *Trimerotropis agrestis barnumi* n.subsp. Lateral view of head and pronotum of Allotype Female, Oak Dunes, Millard County, Utah.
1 b. *T.a.barnumi* showing dorsal view of Allotype Female.
2 b. *T. a. gracewileyae* n. subsp. Lateral view of head and pronotum of Allotype Female, Cane Springs Dunes, 19 miles north of Hanksville, Emery County, Utah.
2 b. *T. a. gracewileyae* showing dorsal view of head and pronotum of Allotype Female.
3a. *T. agrestis* McNeill. Lateral view of head and pronotum of female from Halsey, Nebraska.
3 b. *T. agrestis* McN. Dorsal view of head and pronotum of Halsey female.
All drawings executed to the same scale and 6.5 x natural size. Drawings reduced for reproduction about one-third.

in the anterior portions. In profile, the lateral lobes are deeper than broad, the lateral margins strongly divergent downwards, the posterior angle enormous causing the lower margin to slope strongly downwards caudadly (see fig. 1 a). Tegmina projecting beyond the apices of the caudal femora by one-third their length. Caudal femora slightly heavier than typical in the genus.

Coloration: head and thorax grayish white, profusely mottled with grayish black with suffusions of yellowish on the shoulders of the metazona and the area surrounding the base of the antenna. Tegmina isabelline with the first anal vein area streaked with yellowish for its entire length. Caudal femora with outer pagina mottled with dark gray, upper sulcus mottled and with a yellowish tinge, lower sulcus white. Inner pagina uniformly dull reddish, merging to yellowish at the outer edge of the lower sulcus. Caudal tibiae orange red with a tinge of white at the outer base; tibial teeth half-tipped with black.

Wing twice as long as broad with a black band commencing near the anal angle where it is 3.0 mms wide, edging the hind margin to about midway where it curves forward as a band 6.5 mms broad to narrow slightly as it reaches the central portions of the fore margin; spur very short and blunt barely 2.0 mm. long. Apical portions beyond the band transparent with three veins and venules black, the remainder clear. Disc of wing pale yellow, its breadth about two-fifths the length of the wing.

Holotype: Male: Oak City Dunes, 5 miles WSW Oak City, Millard County, elev. 4600 ft.; July 26, 1960, Ernest R. Tinkham on sand covered with *Psoralea*. Caliper measurements in millimeters: body length 26.2; length to tip tegmen 33.8; pronotum 4.9 x 3.5 at anterior metazonal shoulders; lateral lobes 4.9 max. depth 4.1 max. breadth; tegmen 27.6; caudal femora 14.8. Type in the Tinkham Eremological Cln.

Allotype: Female: Size larger but quite closely similar to the Holotype male in most respects. Fastigium of the vertex broader; the fastigial carinae more divergent forward to the front margin of the eyes, thence more convergent forward to the stricture of the frontal costa just above the antennae. Lateral foveolae, small, their plane horizontal but set below the carinal ridge as if crowning the lateral ocelli. Head otherwise similar to the male. Pronotum, tegmina and other body features identical to the Holotype. Ovipositor developed for sand excavation, the upper valvulae with strongly recurved apices, its surface deeply excavate; lower valvulae typical. Coloration closely similar to the Holotype but with a slightly more yellowish tinge. Wing similar to that in the Holotype.

Allotype: Female: same data as the Holotype. Caliper measurements in millimeters: body length 28.8; length to tip of tegmen 37.2; tegmen 30.6; pronotum 6.8 x 4.0 at metazonal shoulders; lateral lobes 5.5 (shoulder to apex of lateral angle) x 4.2 at maximum breadth. Type in the Tinkham Cln.

Paratype Males: 25♂ from the type locality; 7♂ Hawbush

dunes, 10 miles north Flowell on road to Delta, July 26, 1960; 1 ♂, dunes 10 miles north of Lynndyl, Juab County, June 20, 1958, nymph reared to adult, all Ernest R. Tinkham. Four males, dunes 10 miles north of Lynndyl, July 30, 1957, Andrew Barnum. Range in caliper measurements in millimeters: body length 22.5—25.5; length to tip tegmina 30.0—33.9; tegmina 25.0—28.5; pronotum 4.6—4.8 x 2.9—2.9 (at anterior metazonal shoulders); lateral lobes of pronotum 4.3—5.0 (max. depth) x 3.5—4.0 (max. breadth). Paratypes to be deposited in U.S.N.M., Museum of Zoology at University of Michigan, Academy Nat. Sci. of Philadelphia, Minnesota, Brigham Young, Los Angeles Museum and California Academy of Sciences.

Paratypes identical to the Holotype male with very slight changes in coloration verging to more reddish to match the coloration of the sands.

Paratype Females: 10 ♀ from the type locality of the Allotype; 7 ♀ Hawbush Dunes, July 26, 1960, Ernest R. Tinkham. 4 ♀ dunes 10 miles north of Lynndyl, Juab County, 30 July, 1957, Andrew Barnum. Range in millimeters: body length 26.4—30.6; length to apex tegmina 34.8—39.1; tegmina 29.4—32.7; pronotum 4.8—6.0 x 3.6—4.6; lateral lobes 4.5—5.5 x 3.8—4.7 mm. Deposition as with male Paratypes.

Female paratypes identical to the Allotype in every respect with slight changes in coloration as noted in the male Paratypes.

As I found nymphs only on June 15 and 20 of 1958 at the Flowell and Lynndyl dunes and these emerged as adults a month later, this new race probably does not mature before mid-July on the dunes. I collected several nymphs on July 26, 1960, at the Oak City and Hawbush dunes indicating that molting was not quite complete at this time.

The nymph of *T. a. barnumi* has the lateral lobes of the pronotum even more strikingly enlarged than in the adult and truly is a remarkable creature.

The only other acridids found associated with *T. a. barnumi* in the *Psoralea* habitat on the Oak City dunes were *Trimerotropis p. pallidipennis* and *Melanoplus packardi*. On bare stretches of sand *Trimerotropis strenua* was rare. At night sand treaders were rare as these dunes are very dry. At the Hawbush dunes *barnumi* was associated with *Conozo a. wallula* and *Trimerotropis bilobata* with *Hesperotettix* sp. and *Melanoplus* sp. inhabiting *Chrysothamnus* spp. bushes growing on the low dunes. The nocturnal sand treaders were commoner here because the dunes were lower and damper with meadows and ponds even present in certain places.

The new Western Utah race of *T. agrestis* is named in honor of that young and promising Utah Orthopterist. Mr. Andrew Barnum, whose work on Utah Orthoptera, particularly the Oedipodinae, is commendable.

LITERATURE CITED

McNeill, Jerome. 1901. Revision of the Orthopteran Genus *Trimerotropis*. Proc. USNM 23 (1215):393-449. pl. 21.

Tinkham, Ernest R. 1947. New Species, Records and Faunistic Notes Concerning Orthoptera in Arizona. Amer. Midland Naturalist, 38(1):127-149. 4 pls. with 32 figs. 1959. Notes on the Self-burial habits of two Nearctic Sand Dune Acridids (Orthoptera). The Entomologist, London, 92(1156):185-188, Fig. 5.

NEW RECORDS AND SPECIES OF SCOLYTIDAE (COLEOPTERA) FROM WESTERN NORTH AMERICA

Stephen L. Wood[1]

Significant extensions of the distributions of several species of bark beetles from the western United States and the State of Chihuahua, in Mexico, are reported in the following pages. A genus, *Aphanocleptus*, and six species are described as new to science. The new species represent the following genera: *Carphoborus*, *Chramesus*, *Micracis*, *Aphanocleptus*, and *Ips* (2). In addition, the homonym *Chramesus striatus* Wood is renamed, and notes are included concerning *Xyleborus saxeseni* (Ratz) and *X. xylographus* (Say).

Carphoborus brevisetosus Wood

Only the type series of this species from southern Wyoming has been known previously. It was collected again in Utah at McKee Draw, Ashley National Forest (Uinta Mountains), on June 16, 1960, and at Sanford Canyon, Dixie National Forest, on June 22, 1960, from *Picea pungens*.

Carphoborus perplexus, n. sp.

In the key to North America *Carphoborus* (Wood, 1954, Canadian Ent. 86(11):508) this species would appear to fit *ponderosae* Swaine in couplet twelve. It is, however, more closely allied to *sansoni* Swaine than to other known species. It is distinguished from *ponderosae* by the less strongly elevated more finely serrate declivital interspaces, particularly the ninth which is also less closely tuberculate, and by the absence of a serrate elevation extending from the junction of interspaces three and nine to the apex of interspace one. From *sansoni* it is distinguished by the coarser declivital teeth, and by the tuberculate posterior portion of the ninth declivital interspace.

Female.— Length 1.9 mm., 2.4 times as long as wide.

Frons flattened, weakly elevated along epistomal margin; epistomal margin medially produced in front of mandibles; surface rather coarsely, closely punctured; vestiture long, abundant, rather coarse. Antennal club 1.3 times as long as wide, the sutures straight

Pronotum 1.2 times as wide as long; sides slightly arcuate, indistinctly converging anteriorly, a weak lateral constriction just

1. Contribution No. 174, Zoology and Entomology Department, Brigham Young University, Provo, Utah. Scolytoidea contribution No. 20.

behind the broadly rounded anterior margin; surface reticulate, punctures of moderate size, deep, close; median line elevated only near middle; vestiture consisting of abundant small, erect scales, each scale distinctly longer than wide.

Elytra 1.7 times as long as wide; sides subparallel on basal two-thirds, rather broadly rounded behind, the posterior profile interrupted by the elevated declivital interspaces; basal margins elevated and armed by about nine large crenulations; striae slightly impressed, the punctures rather large, deep, close; interstriae about as wide as striae, weakly convex, the punctures confused, close, deep, rather coarse. Declivital interspaces one and three moderately rather evenly elevated; two rather slender flat; one, three, five, seven, and nine coarsely serrate; nine somewhat more sparsely serrate than others (often with gaps in paratypes); declivital elevation ending at junction of interspaces three and nine, not continued across interspace two. Vestiture consisting of large, abundant, erect, interstrial scales, each scale longer than wide.

Male— Similar to female except frons convex above, strongly, transversely impressed below (longitudinally concave), the median non-tuberculate, transverse elevation as in other species of the genus; surface of frons more coarsely, deeply punctured, and vestiture shorter.

Type locality.— Ten miles east of Kamas, Utah.

Host.— *Pinus ponderosa.*

Type material.— The female holotype, male allotype and 38 paratypes were collected at the type locality on September 9, 1960, from small shaded-out branches of *Pinus ponderosa*, by S. L. Wood and D. E. Bright, Jr.

The holotype, allotype, and some paratypes are in the collection of the writer, other paratypes are in the U.S. National Museum.

Liparthrum arizonicum Wood

Previously known only from the Huachuca Mountains of Arizona, this species was collected on July 17, 1960 at La Laja and at 20 and 23 miles south of Creele, Chihuahua, Mexico, on July 17, 1960. It was common wherever a species of Madrone, either *Arbutus arizonicus* or *glandulosa*, was present.

Carphobius arizonicus Blackman

This unique species was described (Blackman, 1943, Proc. U.S. Natl. Mus. 94(3174):398) from a short series collected in the Huachuca Mountains of Arizona in 1907. The host and further distribution have remained unknown until the species was again encountered during the past summer. Short series were collected 23 miles east of Maguerichic, Chihuahua, Mexico, on July 13, 1960, and again 23 miles south of Creele, Chihuahua, Mexico, on July 18, 1960, from *Juniperus pachyphloea*, by the writer.

Phloeosinus spinosus Blackman

Specimens collected 30 miles south of Creele, Chihuahua, Mexico, on July 18, 1960, from *Cupressus arizonica*, are referred to this species previously known only from Arizona. Compared to a series from the Chiricahua Mountains, the type locality, there are consistent differences in the size of declivital tubercles of the male. However, as the distributional pattern of this species becomes more completely known, the Chihuahua specimens almost certainly will fall well within the limits of variability.

Leperisinus hoferi Blackman

The known distribution of this species has included southern Arizona and New Mexico. During the past summer specimens were collected at Colonia Juarez, Chihuahua, Mexico, on July 22, 1960, from *Fraxinus velutinia*. The same host with galleries of what appeared to be this species was also observed at 23 miles south of Creele, and 16 miles northeast of San Juanito, Chihuahua, although specimens were unobtainable.

Phloeotribus pruni Wood

This species, previously known only from the type series, was collected at Maguerichic, Chihuahua, Mexico, on July 13, 1960. It was taken from both large and small branches of cultivated peach trees. The four trees examined in the area were all severely damaged indicating that this is, or may become, an important economic pest in the area.

Chramesus setosus, n. sp.

This species is closely related to *asperatus* Schaeffer, but may be distinguished by the smaller average size; by the more slender, less abundant vestiture; in the male by the less deeply impressed frons; and in the female by the absence of granules on the upper area of the frons. The prothorax is as coarsely sculptured as in *asperatus*.

Male.— Length 1.4 mm. (paratypes 1.2-1.8), 1.5 times as long as wide; body color black, vestiture yellowish-brown.

Frons deeply, broadly concave between inner margins of eyes from epistomal margin to well above upper margins of eyes, deepest point on upper half; epistoma slightly elevated and with a median lobe projecting in front of mandibles; lateral margins acute and armed by a pair of small teeth as in *asperatus;* surface reticulate, with sparse, fine, inconspicuous punctures; vestiture scanty, inconspicuous. Eye and antenna as in *asperatus*.

Pronotum 1.4 times as wide as long; sides rather strongly, arcuately convergent toward constriction located just behind the broadly rounded anterior margin; surface reticulate with isolated setose granules over entire surface, subasperate in lateral areas,

punctate just in front of scutellum; vestiture rather abundant, bristlelike.

Elytra as in *asperatus* except vesiture less abundant, and both erect bristles and smaller ground setae more slender, not at all scalelike; bristles in rows, erect, as long as those of *asperatus*.

Female.— Similar to male except frons flat with slight interantennal ridge; its surface similar, not granulate above as in *asperatus*; and pronotum with asperities in anterolateral areas much larger.

Type locality.— Madera Canyon, Santa Cruz County, Arizona.

Hosts.— *Rhamnus betulaefolia* (type), and *Morus alba* (paratype.

Type material.— The male holotype, female allotype and 59 paratypes were taken at the type locality on August 1, 1960, from small branches of *Rhamnus betulaefolia*; 18 paratypes were collected at Oak Creek Canyon, Arizona, on July 30, 1960, from the same host; and 107 paratypes were collected at Colonia Juarez, Chihuahua, Mexico, on July 22, 1960, from *Morus alba*; all were collected by S. L. Wood and J. B. Karren.

The holotype, allotype and some paratypes are in the collection of the writer, other paratypes are in the U. S. National Museum.

Chramesus strigatus, n. n.

At the time *Chramesus striatus* Wood (1956, Canadian Ent. 88:256) was described the usage of the same name for another species of this genus by Eggers (1943, Mitt. Munchn. Ent. Ges. 33:344) was unknown to the writer. Since *striatus* Wood is a junior homonym of *striatus* Eggers, the new name *strigatus* is proposed as a replacement.

Micracis carinulatus, n. sp.

This species is more closely allied to *suturalis* Leconte than to other known representatives of the genus, but is readily distinguished in the female by the more broadly concave frons which extends higher on the vertex and which is armed by a sharp, low median carina on the upper half and a row of long hair on the dorsal margin; and in both sexes by the more distinctly serrate anterior margin of the pronotum; by the coarser scalelike elytral vestiture; by the more strongly impressed strial punctures on the declivity; and by the uniformly convex declivital interspaces.

Female.— Length 2.4 mm. (paratypes 1.9-2.5), 3.3 times as long as wide; mature color brown.

Frons broadly concave from epistomal margin to well above upper margin of eyes with a smaller deeper median impression just above epistoma; a sharply elevated, low median carina extending from upper level of eyes to the rounded upper margin of concavity; surface rather coarsely reticulate; vestiture consisting of very short, sparse, recumbent hair within concavity and a row of long yellow

hair along upper margin of concavity extending from eye to eye, some of the hairs at least equal in length to antennal club. Eye large, coarsely faceted, 2.3 times as long as wide. Antennal scape triangularly expanded and setose, similar to *swainei;* club 1.5 times as long as wide, sutures procurved, the first reaching middle.

Pronotum 1.3 times as long as wide; sides straight and parallel on slightly more than basal half then abruptly narrowed to the rather broadly rounded anterior margin; anterior margin armed by a rather indefinite row of about ten small teeth; summit in front of middle, not high, asperate anterior to summit, coarsely reticulate behind and with rather sparse granulate punctures. Vestiture rather short, coarse and bristlelike anteriorly, becoming somewhat scalelike toward base.

Elytra 2.2 times as long as wide; sides straight and parallel on basal three-fourths, mucronate behind; striae not impressed, the punctures, small, distinct, shallow; interstriae feebly convex, twice as wide as striae, almost smooth, the punctures close, about half as large as those of striae, weakly raised (subvulcanate). Declivity steep, convex; striae weakly convex, bearing a row of rather small rounded granules. Vestiture rather abundant; consisting of small, semierect strial hair; and longer bristlelike scales, those on declivity slightly longer and pointed.

Male.— Similar to female except shorter (2.0 mm.), stouter (2.9 times as long as wide); frons convex above shallowly, narrowly concave below with surface granulate; antennal scape less strongly expanded; anterior margin of pronotum strongly serrate; surface of pronotum and elytra somewhat more coarsely sculptured; and elytral scales much broader, not pointed on declivity.

Type locality.— Cave Creek Canyon, Chiricahua Mountains, Arizona.

Host.— *Salix* sp.

Type material.— The female holotype, male allotype and 64 paratypes were collected at the type locality on August 4, 1960, from small branches of the common willow growing along the bank of Cave Creek, by S. L. Wood. Galleries were in the wood and appeared to be similar to those of *suturalis.*

The holotype, allotype, and some paratypes are in the collection of the writer; other paratypes are in the collection of the U.S. National Museum.

Aphanocleptus, n. g.

This genus belongs to the Micracini and is more closely allied to *Stenocleptus* Blackman than other known genera. From *Stenocleptus* it may be distinguished by the evenly convex elytral declivity; by the striate, closely squamous elytra; by the sixth segment of the funicle being as wide or wider than the pedicle; and by the sutures of the antennal club being only sparsely setose.

Description.— Head convex above, moderately impressed be-

low; funicle six-segmented, increasing gradually in width from segment two to six, six wider than pedicle; club elongate, widest on basal half, sutures straight and marked by rows of setae, the three sutures dividing club into segments of about equal length; eye rather large, oval; finely granulate. Median half of anterior half of pronotum coarsely asperate, the summit at middle and rather high. Elytra striate and squamose; declivity evenly convex, the apical margin ascending very slightly. Anterior tibia slender and armed on outer apical margin by three or four small teeth.

Type species.— *Aphanocleptus coniferae*, n. sp.

Aphanocleptus coniferae, n. sp.

Superficially this species resembles certain species of *Pseudothysanoes*, but is readily distinguished by the smaller more slender antennal club which has straight sutures similar to that of *Stenocleptus* and *Phloeocleptus*.

Female.— Length 1.7 mm., 2.9 times as long as wide; body color black, tarsi and antennae lighter.

Frons convex above, shallowly concave on median half below upper level of eyes; epistomal margin medially produced in front of mandibles; surface closely subgranulate-punctate except smooth on epistomal extension. Eye entire, elongate-oval; rather coarsely granulate. Antennal scape scarcely longer than pedicle, triangularly expanded and bearing a tuft of long hair; funicle six-segmented, pedicle as long as 2-4 combined, gradually increasing in width apically, six distinctly wider than pedicle; club 1.7 times as long as wide, apically pointed, widest on proximal half; sutures straight, marked by rows of short setae, the first one-fourth of length from base, the second at middle, the third one-fourth of length from apex.

Pronotum about equal in length and width, subcircular in outline; summit at middle rather high; asperities coarse, sparse except at summit, confined to a definite area and extending from summit anteriorly but not reaching anterior margin; surface behind summit somewhat irregular, apparently reticulate, the punctures rather close, moderately coarse and subgranulate, each bearing a coarse, rather long fimbriate seta.

Elytra 1.9 times as long as wide, 2.2 times as long as pronotum; sides straight and subparallel on basal three-fourths, broadly rounded behind; striae not impressed, the punctures small and separated by about one-half their diameters; interstriae as wide as striae, evidently subreticulate and bearing a single row of subvulcanate punctures each of which bears an erect scale. Scutellum large, flat. Declivity convex, rather steep; striae and strial punctures indistinct, somewhat confused, with the subvulcanate interstrial punctures as on disc, surface partly concealed by vestiture; sutural interspace very feebly elevated. Vestiture consisting of short recumbent fimbriate hairs; and interstrial rows of erect scales each about three to four times as long as wide and almost as long posteriorly as distance

between rows; scales on sutural interspaces forming a double row.

Male.—Smaller. 1.5 mm., stouter, 2.5 times as long as wide; frons more shallowly and broadly impressed; antennal scape less broadly expanded and more sparsely pubescent; pronotum slightly wider than long, and armed by two widely spaced teeth on anterior margin; and elytral scales broader, not more than twice as long as wide, and in less definite (partly double) rows; otherwise similar to female.

Type locality.— Eighteen miles west of La Laja, Chihuahua, Mexico.

Host.— *Picea* sp. (type), and *Pseudotsuga taxifolia* (paratype).

Type material.— The female holotype, male allotype and 28 paratypes were collected at the type locality on July 16, 1960 from shaded-out branches of spruce. Ten paratypes were taken the following day sixteen miles northeast of San Juanito, Chihuahua, Mexico, from Douglas fir. Galleries were transverse and engraved both bark and wood. The two broad egg tunnels extended transversely about 10 mm. in opposite directions from a small irregular nuptial chamber, rarely a short feeding tunnel extended perpendicular to the main gallery. Larval tunnels engraved the wood lightly parallel to its grain, and were as much as 40 mm. in length.

The holotype, allotype and some paratypes are in the collection of the writer; other paratypes are in the U.S. National Museum.

Pseudothysanoes phorodendri Blackman

This species previously has been known from southern Texas and southern Arizona. Specimens were collected in Mexico on July 18, 1960, 35 and again 40 miles south of Creele, Chihuahua, from small *Phorodendron* twigs.

Pseudothysanoes huachucae Blackman

Known previously from the Huachuca Mountains of Arizona, this species was collected in Mexico at La Laja, Chihuahua, on July 16, 1960, and 20 and 25 miles south of Creele, Chihuahua, on July 18, 1960 from *Quercus* sp.

Pseudothysanoes spinura Wood

The original sample of the host shrub from which the type series of this species was collected was not identifiable and remained unknown until another sample from the same shrub recently was obtained. It has now been identified as *Ceanothus integerrimus*.

Six miles north of Chihuahua, Chihuahua, Mexico, a long series of specimens was collected on July 21, 1960 from an unidentified *Rhus*-like shrub. Although minor, consistent differences in the sculpture and armature of the male decivity are apparent, they appear at present to represent only slight geographical variations unworthy of subspecific designation. These consist of slightly smaller and

less numerous spines on declivital interspace one, and a somewhat more strongly impressed submarginal area within the declivital face.

Ips utahensis, n. sp.

This is a common economically important species attacking Engelmann spruce in Utah and the surrounding states. Although it has been known to me for more than fifteen years it has not been recognized as a distinct species until now because of its deceptive resemblance to *hunteri* Swaine. Biological studies of the two species conducted during the past summer remove all doubts concerning the distinctness of these sympatric species.

Superficially this species resembles *perturbatus* Eichhoff in size, coloration, declivital armature, etc. The species *utahensis* may be distinguished from it by the larger more strongly impressed strial punctures, particularly in the lateral areas; by the distinctly, somewhat irregularly punctured interspaces, particularly on interspaces three, four, and five, by the more coarsely, deeply punctured pronotum; and by the less coarsely granulate, more protubrant lower half of the frons. From the more closely allied *hunteri* it is distinguished by its larger size, by the first declivital tooth being distinctly closer to the second than to the suture (the reverse is true in *hunteri*); by the more protubrant, more finely granulate, more densely pubescent frons; by the host and by the galleries.

Female.— Length 4.6 mm. (paratypes 4.0-4.8), 2.4 times as long as wide; mature color dark brown, almost black.

Frons convex, broadly, moderately protruding midway between epistomal margin and upper level of eyes; upper half smooth and shining with moderately sparse, fine, sharp punctures, becoming more closely punctured toward summit of protubrance, and finely, closely granulate below. Vestiture fine, short, moderately abundant on lower half, appearing almost subpilose from a lateral aspect. Eye and antenna as in *hunteri*.

Pronotum as in *hunteri* except somewhat more coarsely, deeply punctured, and vestiture somewhat longer and more abundant at sides.

Elytral profile as in *hunteri;* striae not conspicuously impressed, except the first, the punctures rather coarse, and very deep; interstriae slightly wider than striae, surface smooth and shining, the punctures rather small, irregular, more abundant toward declivity, present on all interspaces, coarser and more abundant in lateral areas, those on posterior portions of interspaces one and two becoming tuberculate. Declivity essentially as in *hunteri*, except first declivital tooth distinctly closer to second tooth than to suture.

Male.— Similar to female except somewhat more coarsely sculptured, declivital teeth larger, and frons less protubrant and more coarsely granulate.

Type locality.— Logan Canyon, Utah.

Host.— *Picea engelmanni.*

Type material.— The female holotype, male allotype and 70 paratypes were collected at the type locality on July 31, 1947, at an evelation of 8500 feet, from *Picea engelmanni*, by S. L. Wood. Two hundred and seventy-five other paratypes were collected from the same host at other Utah localities as follows: Beaver Canyon, Beaver Co., and Puffer Lake, September 10, 1949; Spirit Lake, Uinta Mts., August 3, 1946; Monte Cristo, July 20, 1949; and Wolf Creek Pass, Uinta Mts., June 17, and July 12, 1960. It is also known to occur in Colorado, Wyoming, and southern Idaho.

The egg galleries of this species parallel the grain of the wood. They are usually straight, two egg galleries extending in opposite directions from the entrance tunnel, usually with no suggestion of a nuptial chamber. When a third egg gallery appears, it branches off abruptly, then runs parallel to, just a few millimeters from its companion from the same gallery system, giving the whole the appearance of a tuning fork. Larval mines extend at right angles to the egg galleries, perpendicular to the grain of the wood.

The holotype, allotype and some paratypes are in the collection of the writer, other paratypes are in the U. S. National Museum, and the Canadian National Collection.

Ips hunteri Swaine

Swaine described this species (1917, Dom. Canada Dept. Agric. Ent. Br. Bull. 14(1):31) from a long series collected at Creede, Colorado. After examining the type and a long series of paratypes in the Snow Entomological Collection (University of Kansas) and comparing them with numerous other series collected in Utah and Colorado, it is now apparent that the host of *hunteri* is *Picea pungens* and that it is distinct from the larger more common species found in *Picea engelmanni*, described above.

The completed gallery system usually consists of two egg galleries extending in opposite directions from the entrance tunnel; there is no nuptial chamber. The egg galleries are not oriented with respect to the grain of the wood, but appear to be scattered rather haphazardly through the bark. A few gallery systems are transverse, a few are longitudinal, a few are diagonal, but most of them are curved in such a manner as to avoid crossing one another. If a third egg tunnel appears in a gallery system it usually begins at right angles to the main gallery and may or may not curve toward either of those on the main stem. Larval mines extend more or less at right angles from their points of origin on the egg gallery regardless of its orientation.

Ips sulcifrons, n. sp.

This distinctive species belongs to the *tridens* group and is more closely allied to *pilifrons* Swaine than to other known species. From *pilifrons* it is distinguished by the larger punctures on both the elytral striae and the posterior area of the pronotum; and, in the

female, by the higher, narrower, deeply sulcate frontal elevation.

Female.— Length 4.4 mm. (paratypes 4.0-5.0), 2.6 times as long as wide; body color brown.

Frons strongly protubrant below upper level of eyes on a rather narrow area occupying not more than half the distance between eyes; protubrance deeply cleft by a median sulcus; median surfaces of sulcus densely clothed by minute pilose hair except on a narrow median line at bottom of sulcus; surface smooth and shining above with moderately large, sparse punctures, gradually becoming closely granulate-punctate toward protubrance; vestiture almost entirely restricted to median surfaces of protubrance. Eye and antenna as in *pilifrons.*

Pronotum 1.03 times as long as wide; widest at base, sides feebly arcuate and gradually converging to the rather broadly rounded anterior margin; asperate on anterior half, rather coarsely, closely, deeply punctured in posterior areas.

Elytral profile from dorsal aspect as in *pilifrons;* striae not impressed, except feebly on first, the punctures large, moderately deep, separated by about one-half their own diameters; interstriae as wide as striae, smooth and shining, the punctures small, present on all interspaces, less abundant anteriorly, those on interspace one bearing minutely pointed tubercles from anterior margin of declivity almost to base. Declivity and lateral armature as in *pilifrons.*

Male.— Similar to female, except lower half of frons very feebly protubrant, the surface coarsely, irregularly granulate with the vestiture consisting of moderately abundant fine, long hair; and declivital teeth larger.

Type locality.— Santa Fe, New Mexico.

Host.— Unknown.

Type material.— The female holotype, male allotype and 24 paratypes were collected at the type locality on October 6, 1949, by Owen Bryant. In addition, the holotype, allotype and nine paratypes bear the lot number 59.

The holotype, allotype and some paratypes are in the collection of the California Academy of Sciences; other paratypes are in the U. S. National Museum, the Canadian National Collection, and the collection of the writer.

Xyleborus saxeseni (Ratzeburg)

Recently Dr. K. E. Schedl (1960, Coleopterists' Bull. 14:11) placed *Bostrichus saxeseni* Ratzeburg (1837, Die Forstinsekten 1:167) in synonymy under *Bostrichus xylographus* Say (1826, Jour. Acad. Nat. Sci. Philadelphia 5:256). Although it is agreed that the species to which he referred is widely distributed in Europe and North America, it is apparent that a misidentification has led to an error in synonymy.

It has been presumed that the entire type series of Say's species

xylographus was lost. There is, however, a single specimen among Swaine's material in the Canadian National Collection bearing the label "*Bostrichus xylographus*, teste Say," evidently written by Leconte. Whether or not this specimen actually belonged to the type series is problematical; however, because of Swaine's intimate knowledge of and repeated use of the Leconte Collection and because of the well known connection between Leconte and Say, there is good reason to believe this specimen is as nearly authentic as any existing specimen that has been referred to Say's species. To my knowledge there has never been disagreement among North American writers concerning the identity of Say's species. The reason for this agreement evidently was the existence of the above mentioned specimen.

The species *xylographus* (Say) belongs to the *Xyleborus* (s. str.) and *saxeseni* (Ratzeburg) to the subgenus *Xyleborinus*. Both species are widely distributed and common in North America.

Pityoborus secundus Blackman

Previously this species has been known only from the La Sal Mountains of Utah. On July 30, 1960, at Oak Creek Canyon, Arizona, it was collected again from the small shaded-out branches of *Pinus ponderosa*.

Pseudopityophthorus pulvereus Blackman

Specimens of this species were collected at La Laja, Chihuahua, Mexico, on July 16, 1960, and 23 miles south of Creele, on July 18, 1960, from *Quercus sp.*

Pseudopityophthorus yavappi Blackman

Specimens of this species were taken from the same branches at the same two localities as the above species, *P. pulvereus*.

Pityophthorus virilis Blackman

Previously unknown from Mexico, this species was collected 16 miles northeast of San Juanito, Chihuahua, on July 19, 1960, from *Rhus trilobata*.

Pityophthorus juglandis Blackman

This species was collected six miles north of Chihuahua, Chihuahua, Mexico, on July 21, 1960, from native black walnut (*Juglans* sp.)

Margaret Hamilton Storey (1900-1960)

As this number of the Great Basin Naturalist goes to press, we are saddened to learn of the death of Margaret Storey. Margaret was born in San Francisco on July 31, 1900. She was the eldest daughter of Dr. and Mrs. Thomas Storey, who for many years was the director of the Department of Health and Athletics at Stanford University. Margaret Storey received her academic training at Cornell University—A.B. degree in 1922—and Stanford University—M.A. degree in 1936. From 1935 until her death she was associated with the Natural History Museum of Stanford University.

As an Associate Curator of Zoological Collections, she rendered invaluable service to the museum. The Director of the Museum, Dr. George S. Myers[1], paid her the following tribute: "She not only acted as curator, but also as librarian, editor, counsellor, and helpful assistant to everybody—faculty, graduate students, and visiting investigators alike—who worked in the Museum."

Margaret Storey's passing will leave a great void in the Museum staff. This writer always looked forward to visiting with her when on the Stanford Campus. I shall long remember my visit with her at the Museum in August of this year. *Vasco M. Tanner.*

1. Stanford Ichthyological Bulletin, Vol 7, No 4, p. 62a, 1960.

ARTHROPOD CONSORTES OF A KIT FOX DEN[1]

J Franklin Howell[2, 3]

Studies of the kit fox, *Vulpes macrotis nevadensis* Goldman, in Utah prior to 1956 had been concerned primarily with taxonomy and distribution. The recent study by Egoscue (1956) of the life history and habits of the kit fox was a timely and much needed contribution to our knowledge of this animal. One objective of his study was to determine the potential role of this fox in the epizoology of endemic diseases. To understand the various epidemiological implications and to develop host-parasite relationships, the arthropod contents of a den were examined. The objective of the present study is to report on the arthropods recovered by Egoscue (1956) from a kit fox den. To the extent of the author's knowledge such information has not previously been reported. It is unfortunate that fox populations were not large enough to permit excavation of several dens without upsetting other phases of study.

Methods and Materials

Beginning with the dirt ramp (Fig. 1) and at given intervals (Table I) within the tunnel, blocks of soil were collected and screened through a series of soil sieves, the smallest having a 200 mesh screen. Each block was the width of the tunnel floor, two inches in depth, and six to eight inches long. To eliminate screening large volumes of soil it was necessary to take each sample before the tunnel floor was disturbed or covered with soil loosened by excavation. Therefore, each sample was obtained by reaching into the tunnel 15 to 18 inches beyond the point to which excavation had progressed. All arthropods recovered were transferred to 70 per cent alcohol with forceps and a camel's-hair brush.

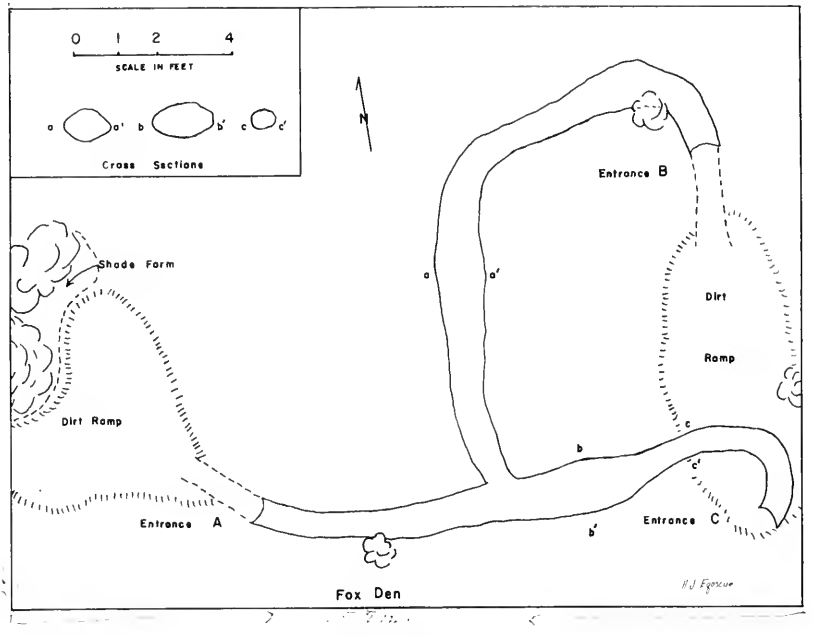
Mites, lice, and fleas were mounted on microslides for identification. The mites were mounted in poly-vinyl-alcohol (PVA); fleas and lice were cleared with sodium hydroxide and mounted in balsam. The ticks and larval insects were identified without mounting.

Results and Discussion

Egoscue (1956) states that previous to excavation the den was occupied by a family of six. the female fox and five pups and that

1. This work was supported by the U.S. Army Chemical Corps Contract No. DA-18-064-CML-2639, with the University of Utah.
2. Presently with the Department of Entomology, Washington State University, Pullman, Washington.
3. The author wishes to extend his appreciation to Harold J. Egoscue and William J. Bacha Jr. for making this material available; to Dorald M. Allred for identifying the mites; to Carlo Ignoffo for identifying the lice; to D. Elmer Johnson for identifying the non-parasitic insects; to Glen M. Kohls for identifying *Ixodes kingi* Bishopp and *Ornithodoros parkeri* Cooley. Appreciation is also extended to the members of the staff of the Ecological Research Division, University of Utah, for their assistance and timely suggestions, and to M. T. James for reviewing this manuscript.

they abandoned the den May 16, 1955. The den was excavated following three days of surveillance to make sure the fox did not return. It was located in a geological lake bottom sparsely vegetated primarily with scadscale, *Atriplex confertifolia*, three miles west of Little Granite Mountain, Dugway Proving Grounds, Tooele County,



Fox Den

Utah. Egocue has described the environmental responses and proposed several reasons why a fox would abandon its den.

From field observations, scat analysis, and through recovery of the remains of prey not completely consumed Egoscue (1956) has identified the following as prey species of the kit fox: black-tailed jack rabbit, *Lepus californicus;* kangaroo rat, *Dipodomys ordii;* deer mouse, *Peromyscus maniculatus;* burrowing owl, *Speotyto cunicularia;* horned lark, *Eremophila alpestris;* meadow lark, *Sturnella neglecta;* brown-shouldered lizard, *Uta stansburiana;* and the sand cricket, *Stenopelmatus* sp.

Because of specific interest in arthropods potentially capable of disease transmission the majority of this discussion will be limited to this group. The reader interested in ectoparasites collected from the kit fox is referred to Egoscue's (1956) study.

Class Insecta:—The non-parasitic insects collected are scavenger species and are distributed throughout the locality (Table II). This discussion will make no further reference to this group. Regarding

the single species of Mallophaga (*Felicola vulpis* (Denny)) collected, Hopkins and Clay (1952) give *Vulpes* as the only host from which this species has been collected. Since lice normally pass through their entire life cycle on the host, the den or nest would not be expected to yield a large number of these insects.

Pulex irritans L. was collected repeatedly from foxes trapped during Egoscue's (1956) study; therefore, its presence would be expected in the fox den. *P. irritans* is commonly associated with the larger carnivores and man (Smit, 1958) and is capable of transmitting plague to man (Eskey and Haas, 1940). However, Smit (1958) feels that its significance in maintaining natural reservoirs of plague has been overestimated. Since the re-recognition of *P. simulans* Baker by Smit (1958), much of the work on plague transmission within this flea complex must be re-evaluated.

The fleas *Monosyllus wagneri* Baker and *Meringis parkeri* Jordan have not been collected from the fox. However, both have been repeatedly collected from the rodents *D. ordii* and *P. maniculatus*.

TABLE I. Location of soil collection sites in kit fox den.

Entrance A		Entrance B		Entrance C	
Collection number	Depth within den	Collection number	Depth within den	Collection number	Depth within den
1	At entrance	1	At entrance	1	At entrance
2	6 in.	2	6 in.	2	6 in.
3	12 in.	3	12 in.	3	12 in.
4	18 in.	4	18 in.	4	18 in.
5	30 in.	5	30 in.	5	30 in.
6	64 in.	6^0	64 in.		
7	76 in.	6^1	88 in.		
8	88 in.	6^2	112 in.		
		6^3	138 in.		
		6^4	162 in.		
		7	174 in.		
		8	186 in.		

Table II. Arthropod consortes collected in the fox den.

Arthropod Consortes	Number of Specimens
Class Arachnoidea	
Order Acarina	
Suborder Mesostigmata	
Superfamily Gamasides	
Family Laelaptidae	
Haemolaelaps glasgowi	large numbers*
Haemolaelaps casalis	large numbers
Superfamily Ixodoidea	
Family Argasidae	
Ornithodoros parkeri	26 larvae
Family Ixodidae	
Dermacentor parumapertus	20 larvae and nymphs
Ixodes kingi	1 larva
Ixodes texanus	112 larvae and nymphs
Class Insecta	
Order Coleoptera**	
Family Staphylinidae	2
Family Histeridae	12
Family Tenebrionidae	
Tenebrio sp.	1
Family Trogidae	
Trox sp.	23
Order Isoptera	1
Order Mallophaga	
Family Trichodectidae	
Felicola vulpis	3
Order Siphonaptera	
Family Ceratiphyllidae	
Monopsyllus wagneri wagneri	1
Family Hystrichopsyllidae	
Meringis parkeri	1
Family Pulicidae	
Pulex irritans	5
Unidentified larvae	62

*Hundreds of mites were collected at each sample location. Subsamples of ten from each location were identified.

**Three specimens of larval Coleoptera and one of Lepidoptera were collected but not identified.

Table III. Location in the den where arthropods were collected.*

Fleas	Ticks	Mites	Lice	Beetles	*Ornithodoros parkeri*
1 A**	1 A	6 A	7 A	2 A	6 A
2 A	2 A	7 A	3 C	5 A	7 A
7 A	4 A	8 A	5 C	6 A	8 A
2 B	5 A	6[2]B		7 A	6[1]B
5 B	6 A			2 B	6[3]B
6[5]B	7 A			5 B	6[4]B
3 C	8 A			6[0]B	
	1 B			6[2]B	
	2 B			2 C	
	3 B			3 C	
	4 B			5 C	
	6[0]B				
	6[1]B				
	6[2]B				
	6[3]B				
	6[4]B				
	5 C				

*Refer to Table I for reference to collection data.

**A, B, and C represent the entrances to the den.

Since their relative numbers (Table II) were very low, it may be assumed these specimens were introduced into the den on animals used for food. *M. wagneri* has been shown to be a potential vector of plague (Eskey and Haas, 1940). Information on *M. parkeri* as a potential vector of diseases is not available.

Class Archnoidea:—Although frequently collected from hosts within this study area, *Haemolaelaps casalis* (Berlese) (= *H. megaventralis*), and *H. glasgowi* (Ewing) have not previously been collected from the kit fox nor its den. In nature, *H. casalis* has been obtained most often from debris rather than from the host's body (Strandtomann and Wharton, 1958). This is not necessarily the case with *H. glasgowi*. Both are collected from a wide range of hosts.

Strandtmann and Wharton (1958) designate *H. glasgowi* as one of the known cosmopolitan mites. Russian workers, according to Strandtmann and Wharton (1958, p. 39), have reported this species to be naturally infected with tularemia and that they successfully transmit the disease. From the large numbers collected (Table II) it appears that the kit fox den is a natural habitat for these mites.

Ornithodoros parkeri Cooley is distributed throughout the eastern and southern parts of Utah and surrounding states. Previous to this study, *O. parkeri* had not been collected in the Great Basin, with the possible exception of a few collections in Nevada (Cooley and Kohls, 1944). Recently, collections in addition to those made during this study have been made from kangaroo rat caches (Johnson, personal communication)[4] in Tooele County, Utah. Collection data show that this tick is usually associated with dens, burrows, and food caches rather than with the host proper (Cooley and Kohls, 1944). It was of considerable interest to note that this tick was collected only in the deeper portions of the den (Table III). Several diseases have been experimentally transmitted by this tick (Davis, 1941). Ticks having natural infestations of relapsing fever spirochetes have often been collected in Utah and adjacent states (Davis, 1941, 1942). The identification of *O. parkeri* is only provisional since it was made from larval specimens. Two other related argasid ticks are found within the area; a behaviorally atypical *O. hermsi* Wheeler, Herms and Meyer (Davis and Mavros, 1956), and possibly *O. cooleyi* McIvor (Cooley and Kohls, 1944).

Ixodes texanus Banks was collected from the kit fox by Egoscue (1956), establishing a new host record. Infrequently this tick has been collected within the study area (Woodbury, 1956) in small numbers. Darsie and Anastos (1957) state that *I. texanus* is not in the least host specific. They list approximately 40 mammals as hosts. However, the larger collections have been made from weasels, pine squirrels, raccoons, and skunks. The relatively large numbers collected (Table II) would suggest that the kit fox den is a natural habitat for this species.

Ixodes kingi Bishopp has not previously been collected from the kit fox nor its den, although it has been frequently collected from native rodents (Allred, 1955). The single specimen collected (Table II) would suggest its introduction into the den via prey animals.

Dermacentor parumapertus Neumann is the most commonly collected tick locally, and may be collected from essentially any small mammal in the area. Due to the abundance of this tick and to the associations the fox has with other mammals, its presence in the den is readily explained. This tick is a potential vector of tularemia (Woodbury and Parker, 1954).

Summary

.....Two species of fleas, two species of ticks and one mite of known medical importance have been recovered from the kit fox den. The

4. D. Elmer Johnson, Entomologist, Ecological Research, Univ. of Utah, Dugway, Utah.

ticks *I. kingi*, *I. texanus* and *O. parkeri* represent new host and/or distribution records. *H. casalis*, *H. glasgowi*, *I. texanus*, *O. parkeri*, *F. vulpis* and *P. irritans* appear to be natural associates of the kit fox. The remainder of the arthropods are scavengers or considered to be accidental transfers from prey animals.

Literature Cited

Allred, Dorald M. 1955. Ticks and mites as potential vectors. *In:* Symposium on Ecology of Disease Transmission in Native Animals. Ecol. Res. Univ. of Utah. p. 66-69.

Cooley, R. A. and Kohls, Glen M. 1944. The Argasidae of North America, Central America and Cuba. Amer. Midland Nat., Monograph No. 1. Notre Dame Univ. Press. 152 pp. illus.

Cooley, R. A. and Kohls, Glen M. 1945. The genus Ixodes in North America. Natl. Inst. of Health Bull. No. 184. U. S. Govt. Printing Office, Washington, D.C. 246 pp. illus.

Darsie, Richard F. and Anastos, George. 1957. Geographical distribution and hosts of *Ixodes texanus* Banks (Acarina, Ixodidae). Ann. Ent. Soc. Amer. 50(3):295-301.

Davis, Gordon E. 1941. *Ornithodoros parkeri* Cooley: Observations on the of this tick. Jour Parasit. 27(5):425-433.

——. 1941 a. *Ornithodoros parkeri* and relapsing fever spirochetes in Utah. Pub. Health Rpts. 56(52):2464-2468.

Davis, Gordon E. and Mavros, A. J. 1956. An atypical *Ornithodoros hermsi* from Utah (Ixodoidea; Argasidae). Jour. Parasit. 42(3):293-296.

Egoscue, Harold J. 1956. Preliminary studies of the kit fox in Utah. Jour. Mammalogy. 37(3):351-357.

Eskey, C. R. and Haas, V. H. 1940. Plague in the western part of the United States. Publ. Health Rpts. 54:1467-1481. illus.

Hopkins, G. H. E. and Clay, Theresa. 1952. A check list of the genera and species of Mallophaga. Brit. Mus. of Natl. Hist., London. 362 pp.

Smit, F. G. A. M. 1958. A preliminary note on the occurrence of *Pulex irritans* L. and *Pulex simulans* Baker in North America. Jour. Parasit. 44(5):523-526.

Strandtmann, R. W. and Wharton, G. W. 1958. Manual of Mesostigmatid mites. Inst. of Acarology, Univ. of Maryland, College Park. Contribution No. 4. 330 pp. illus.

Woodbury, Angus M. 1956. Ecological check lists, the Great Salt Lake Desert Series, Ecol. Res., Univ. of Utah. 125 pp.

Woodbury, Angus M. and Parker, Dale D. 1954. Studies of tularemia, *Pasteurella tularensis*. Special Rept. No. 2. Ecol. Res., Univ. of Utah. 14 pp.

Sir Guy Marshall (1871-1958)

Sir Guy Marshall was born in India in 1871 and died at his home in London on April 8, 1958 at the age of 87. While a student at Charterhouse he began a study of Entomology which continued through his life. In 1895 and for the following eleven years he was employed by a mining firm in Southern Rhodesia. Here he made collections of beetles and studied the mimicry and protective resemblance of many organisms. He published the results of this study in 1902. In 1909 he was appointed Scientific Secretary to the Entomological Research Committee of Tropical Africa. Marshall's masterful handling of the affairs of this Research Committee led to the establishment of the Imperial Institute of Entomology which has meant so much to applied Entomology throughout the World. As Director of the Institute, Marshall was responsible for the founding of the journals, "The Bulletin of Entomological Research" and the "Review of Applied Entomology." He was also a member for thirty years of the editorial board of the "Annals and Magazine of Natural History."

Sir Guy Marshall's entomological specialty was that of dealing with the systematics and economic importance of the large family of weevils—the Curculionidae. During his sixty years of studying this family of beetles he published more than two hundred papers and described 2,300 species. He became the recognized world authority on the weevils. His papers are indispensible when dealing with the taxonomy of this group. His late study on the tribe Celeuthetini, as found in Oceania, is an excellent work. He was cooperative and generous in his dealings with other workers in the weevils. I felt the kindness and warmth of his spirit while working in the British Museum of Natural History during the month of June, 1957. He was most generous in giving advice and weevil specimens to me. Students of entomology, especially of the weevils, will long be indebted to Sir Guy Marshall for his many services and contributions.—*V. M. Tanner.*

NOTES ON AMBLYCHEILA UTAHENSIS TANNER (COLEOPTERA: CICINDELIDAE)

Andrew H. Barnum*

The tiger beetle, *Amblycheila utahensis* Tanner, was described[1] from one male specimen collected at Dameron (Diamond) Valley, 15 miles north of St. George, Washington County, Utah, but nothing was recorded as to its habitat.

A concentrated effort was made to collect specimens of this nocturnal, flightless beetle and on April 30, 1960, a colony of beetles was discovered by the author. Between this date and May 2, 1960, 21 specimens of both sexes were collected by the author and two of his students, A. Dean Stock and Peter Nyberg. This insect proved to be fairly common in an area across the road and northeast from the smaller of the two volcanoes in south Dameron Valley in an area of white (Navajo) sandstone ledges and fallen rocks. At the base of each small hill of white sand was very loose, but dunes were prevented from forming by the sparse vegetation. All the specimens were found near the base of the hill, under flat sandstone rocks of various sizes, and all were found singly with but one exception when three specimens were found under the same large rock. Most of the specimens were kept alive in the laboratory for six to seven weeks and many different kinds of live insects were introduced for food. It was found, however, that of the different insects so introduced, the only acceptable food was a fairly large (15-20 mm. long) darkling beetle, *Eleodes omissa* subspecies *pygmaea* Blais, commonly occurring under the same rocks with the tiger beetles. There was no cannibalism among the specimens kept together in the container.

Subsequently, on June 7, 1960, two additional specimens were collected by the author and T. Blaine Moore of Snow College in a similar area, approximately one mile to the northwest. Both specimens were located in an environment identical to that of the original discovery.

After an examination of the entire series of specimens, the following additions and corrections are made to the original description.

The head and prothorax are shiny but not glabrous, as reported by Tanner, but are ornamented with setae, there being eight to twelve long golden-colored setae sparsely scattered dorsally on the prothorax, and a mixture of many long golden-colored and black setae on the head. The proximal four antennal segments are shiny

*Dixie College, St. George, Utah.

1. Vasco M. Tanner. Notes on some Cicindelidae of the Western United States and the South Pacific Islands with a Description of a New Species. The Great Basin Naturalist, Vol. XI (Nos. 1-2), 1951, pp 47-48.

black and ornamented with long black setae; the distal seven segments black with very numerous short golden-colored setae in addition to the few long golden-colored setae, all of which give these distal segments a decided brownish color.

There is no difference in size between the sexes, the total length of the series averaging 23.5 mm. (22-24.5 mm.).

No larval forms were found, so nothing is known of the developmental stages of the insect. It is assumed, however, that the larvae will be found underneath the rocks as are the adults.

A Necessary Correction

In the previous number of the Naturalist (Drake and Ruhoff 1960, vol. 20, pp. 29-38) the following corrections should be made:

p. 30. change the figure caption "Fig. 1. *Ambotingis senta* (Drake and Hambleton)" to read "Fig. 2. *Dulinius unicolor* (Signoret)."

p. 33. change the figure caption "Fig. 2. *Dulinius unicolor* (Signoret)" to read "Fig. 1. *Ambotingis senta* (Drake and Hambleton)".

— Drake and Ruhoff

THE SIMULIIDAE (DIPTERA) OF UTAH, PART I. KEYS, ORIGINAL CITATIONS, TYPES AND DISTRIBUTION

B. V. Peterson[1]

The Simuliidae are small, inconspicuous insects, but many of them are vicious biters and are extremely annoying to man and other animals. They often attack with terrible severity and in some cases have occurred in such great numbers as to cause the death of their victims (Riley, 1887; Lugger, 1896; Millar and Rempel, 1944; Rempel and Arnason, 1947). Certain species of black flies are known to be vectors of important diseases of man and other animals, and other species are suspected of being of medical importance. As a result, black flies have attracted considerable attention in many parts of the world. In North America, north of Mexico, workers have largely confined their attention to certain regions of Alaska, north and eastern Canada, and the eastern United States. With an ever increasing interest in the black flies of North America and the general paucity of information on the western fauna, it seems worthwhile to present certain aspects of research recently conducted on the black flies of Utah.

Peterson (1955) briefly reviewed the literature directly concerned with the black-fly fauna of Utah. Since that time a number of additional papers on the biology and taxonomy of the simuliid fauna of the area have been published (Peterson, 1956, 1958, 1959a, 1959b, 1959c, 1960; Peterson and DeFoliart, 1960; DeFoliart and Peterson, 1960; Stone and Peterson, 1958; Stone and DeFoliart, 1959). In the present paper an attempt has been made to present workable keys to the females, males and pupae; provide information on type specimens, and list the general distribution of the species in Utah, as well as furnish additional knowledge on the general distribution of these species in western North America.

Current black-fly classification is in a state of flux with only a glimmer of universal agreement appearing on the horizon. This applies not only to the generic and subgeneric categories but, in a number of instances, to species as well. A number of species listed herein (indicated in the keys by an *) may eventually prove to be complexes of several species, and others originally described from the Palaearctic region may prove to be different than Nearctic species bearing the same names. No attempt is made, at this time, to solve such problems, but rather, to indicate the present status of the species under consideration. In this regard, this paper provides a starting point for future studies on the black flies of Utah.

At least nine undescribed simuliid species are known to occur in the state in addition to the 43 species listed in this study. Most of these are known only from one or more of the immature stages, or from an incomplete series of adult specimens. Descriptions of these

1. Entomology Laboratory, Research Branch, Canada Department of Agriculture, Guelph, Ontario

latter species must wait until future collecting provides additional material for study.

Keys to the Genera of North American Simuliidae[2]

Adults

1. Scutum with stout, erect hairs but no fine recumbent hairs; antenna 9-segmented; a bulla behind eye laterally ..... *Gymnopais* Stone
   Scutum usually with fine recumbent hairs but never stout, erect hairs; antenna with 9-11 segments; with or without a bulla behind eye laterally 2
2. Costa with fine hairs only, not interspersed with spinules; radial sector distinctly forked apically; with or without a bulla behind eye laterally 3
   Costa usually with spinules interspersed among the fine hairs; radial sector simple (occasionally obscurely forked at extreme apical portion); no bulla behind eye 5
3. Vein R_1 joining costa at about middle of wing; fork of radial sector ending before termination of costa; m-cu fold apparently unforked; vein Cu_2 nearly straight ..... *Parasimulium* Malloch
   Vein R_1 joining costa well beyond middle of wing; fork of radial sector ending near termination of costa; m-cu fold forked apically; vein Cu_2 sinuous 4
4. Antenna 9-segmented; at least an indication of a bulla behind eye; ovipositor of female short, not reaching anal lobes; dististyle of male with a single apical spine ..... *Twinnia* Stone and Jamnback
   Antenna 10- or 11-segmented (9-segmented in *P. gibsoni*); no bulla behind eye; ovipositor of female usually extending to or beyond anal lobes; dististyle of male often with more than one apical spine ..... *Prosimulium* Roubaud
5. Length of vein R not less than one-third the remaining distance to apex of wing, with hair dorsally; basal cell of wing usually distinguishable; second hind tarsal segment without pedisulcus or this represented by a shallow depression only ..... *Cnephia* Enderlein
   Length of vein R equal to much less than one-third the remaining distance to apex of wing, with or without hair dorsally; basal cell of wing absent; second hind tarsal segment with a distinct, usually deep pedisulcus ..... *Simulium* Latreille

Pupae

1. Dorsum of abdomen without hooks; sternites 4-6 each with about ten hooks some of which occur in more than one transverse row; almost no cocoon ..... *Gymnopais*
   Dorsum of abdomen with hooks on some of the segments; if sternites 4-6 have more than four hooks these are in a single transverse row; cocoon variable 2
2. Cocoon irregular, shapeless, without a well defined anterior margin; terminal abdominal segment with two large spines 3
   Cocoon usually well developed, variously shaped, usually with a well defined anterior margin; terminal abdominal segment with two short spines or none 6
3. Tergites 6-8 without an anterior row of fine spine-like hooks ..... *Twinnia*
   Tergites 6-8, at least, each with an anterior row of fine spine-like hooks 4
4. Respiratory filaments arising from a rounded knob on a short petiole ..... *Cnephia*

2. For a discussion of the general morphology used in the keys the reader is referred to the work of Stone and Jamnback (1955).

Respiratory filaments not arising from a rounded knob on a short petiole 5
5. Respiratory filaments 12 or less, arising from two main trunks ..... *Cnephia*
Respiratory filaments if less than 12, not arising from two main trunks ..... *Prosimulium*
6. Cocoon stalked, and anterior margin not well defined; or, if not so, lateral margins of terminal segment with short, curved, double or treble pronged, or single hooks ..... *Cnephia*
Cocoon not stalked, and anterior margin well defined; lateral margins of terminal segment without short, curved hooks although setae may be present ..... *Simulium*

Larvae[3]

1. Larvae lacking cephalic fans; anal cross-piece Y-shaped 2
Larvae with cephalic fans; anal cross-piece X-shaped 3
2. Labrum enlarged and densely hairy; mandible with small teeth on outer subapical margin ..... *Gymnopais*
Labrum normal, not enlarged but densely hairy; mandible without small teeth on outer subapical margin ..... *Twinnia*
3. Tips of secondary mouth fan (under primary fan) when expanded, forming a straight line; antenna with segments 1 and 2 colorless, segments 3 and 4 darkly pigmented; median tooth of submentum trifid; anal gill with three simple lobes ..... *Prosimulium*
Tips of secondary mouth fan, when expanded, forming an arc; antenna with segments 1 and 2 yellow to brown, segments 3 and 4 rarely dark brown; median tooth of submentum single; anal gill with three simple or compound lobes 4
4. Submentum with large and subequal outer and median teeth and three smaller subequal intermediate teeth on each side; anal gill with three compound lobes (except *S.* (*Eusimulum*) *aureum* and *S.* (*Neosimulium*) ..... *Simulium*
Submentum variable but not as above; anal gill with three simple lobes ..... *Cnephia*

Keys to the Utah Species of *Prosimulium*

Females

1. Antenna 10-segmented ..... *unicum*
Antenna 11-segmented 2
2. Claws each with a strong, thumb-like, basal projection; frons narrow, nearly parallel sided ..... *onychodactylum**
Claws simple, frons broad, widening above 3
3. Integument orange ..... *fulvum*
Integument basically brown to black 4
4. Antenna entirely bright yellow; legs mostly yellow ..... *flaviantennus*
Antenna brown to black, at most with basal two segments yellow; legs variable 5
5. Arms of genital rod expanding distally into enlarged plates, each with a long, slender, medial projection; ovipositor flaps short, not reaching tips of anal lobes 6
Arms of genital rod expanded into plates but these plates with at most, short, medial projections; ovipositor flaps longer, reaching or extending beyond tips of anal lobes 7
6. Genital rod short, arms short and narrow, expanding distally into enlarged, concave, triangular plates, the slender medial projections

3. This key can be safely used only for larvae having well developed white or darkened respiratory histoblasts.

of the two plates often nearly touching; ovipositor flaps broadly rounded along entire outside margins, medial margins narrowly sclerotized; cercus twice as broad as long ..... *daviesi*
Genital rod long, arms long and narrow, widely divergent in the shape of a broad U, enlarged terminal plates quadrate, with inner distal margins produced medially as long, slender, curved projections; ovipositor flaps not broadly rounded along entire outside margins, medial margins broadly sclerotized; cercus only about one-fourth wider than long ..... *shewelli*

7. Anal lobe extending posteriorly beyond cercus a distance about equal to the length of the cercus itself; ovipositor flaps extending nearly to tips of anal lobes; genital rod laterally compressed, long and sinuous, arms twisting so they appear flattened dorsoventrally, expanding into C-shaped plates; small species (about 2.5 mm.) .... *longilobum*
Anal lobe shorter, at most, extending only a short distance beyond posterior margin of cercus; ovipositor flaps variably shorter; genital rod not laterally compressed, and arms not twisting; larger species (3.0 mm. or over) 8
8. Sides of thorax and abdomen distinctly ashy gray; clypeus strongly convex; ovipositor flaps and anal lobes short, the latter not projecting posteriorly and not approaching apex of the rounded cerci .... *travisi*
Sides of thorax and abdomen not distinctly ashy gray, at most with faint gray tinge; clypeus flat, not strongly convex; ovipositor flaps and anal lobes usually closely approaching or extending slightly beyond apex of cerci 9
9. Outer margins of ovipositor flaps broadly rounded basally, flaps acutely rounded apically, reaching tips of anal lobes; genital rod long and slender, arms expanding into plates, each with a short, medial projection; scape and pedicel of antenna darker than other segments ..... *uinta*
Outer margins of ovipositor flaps not broadly rounded basally, flaps bluntly rounded apically, reaching or extending beyond tips of anal lobes; genital rod short, narrowly forked, terminal plates each with a sclerotized, triangular area; scape and pedicel of antenna concolorous or lighter than other segments ..... *exigens**

Males[4]

1. Integument of thorax orange; apex of dististyle truncate ..... *fulvum*
Integument of thorax basically brown to black; apex of dististyle variable 2
2. Antenna entirely yellow; legs mostly pale yellow ..... *flaviantennus*
Antenna brown to black, legs darker 3
3. Apex of dististyle pointed, with two terminal spines; ventral plate broad, shallow, V-shaped; basal two segments of hind tarsi swollen, disproportionately broader than remaining segments ..... *onychodactylum**
Apex of dististyle rounded or truncate, with two or more terminal spines; ventral plate not as above; basal two segments of hind tarsi not disproportionately broader than remaining segments. 4
4. Ventral plate with a compressed, median keel; paramer with large, flattened, oblong or rounded, sclerotized plates apically, and a long, slender, sclerotized rod basally 5
Ventral plate without a compressed, median keel; paramer not as above or absent 6
5. Ventral plate with a prominent, laterally compressed, oblong, median keel; paramer with a rounded, sclerotized plate; dististyle short, tapering distally, with 3-4 terminal spines ..... *exigens**
Ventral plate with a median, triangular keel that is less compressed

4. The males of *P. longilobum* and *P unicum* are not known.

laterally; paramer with an elongate, sclerotized plate; dististyle short and broad, width at base more than one-half the total length, rounded apically, with three terminal spines ..... *uinta*

6. First abdominal segment with fringe of fine, brown hair; paramer a slender, sclerotized bar with a spine-like projection on its dorsal surface at about one-half its length, this bar enlarging plate-like where it attaches to basistyle ..... *shewelli*
First abdominal segment with fringe of fine, yellow hair; paramer not as above 7

7. Median recurved lip of ventral plate narrow and sharply pointed; integument of thorax dark brownish-black; legs dark ..... *travisi*
Median recurved lip of ventral plate broad and bluntly pointed; integument of thorax with an orange tinge; legs lighter yellowish-brown ..... *daviesi*

Pupae[5]

1. Respiratory organ consisting of two stout clubs on a short petiole, from each of which arise 16-20 slender filaments ..... *onychodactylum**
Respiratory organ not club-like, but consisting of a series of slender filaments 2

2. Respiratory filaments 26 or less 3
Respiratory filaments 80-110 or more, short and tuft-like ..... *exigens**

3. Respiratory filaments 10-12, arising from three broadly separated trunks ..... *shewelli*
Respiratory filaments 16 or more 4

4. Respiratory filaments 16 5
Respiratory filaments 20-26 7

5. Respiratory filaments closely clumped together; dorsum of head and thorax strongly rugose ..... *travisi*
Respiratory filaments not closely clumped, more divergent; dorsum of head and thorax not strongly rugose 6

6. Pupa brown in color; terminal spines not set on strong convexities; abdominal sternite 4 with one or two small hooks on each side of posterior margin; medium in size (3.0-4.0 mm.) ..... *daviesi*
Pupa more orange in color; terminal spines each set on a strong convexity; abdominal sternite 4 with one small hook on each side of posterior margin or none, often with small setae; larger in size (4.5-6.0 mm.) ..... *fulvum*

7. Respiratory filaments 21-24 (av. 22) arising from three main groups; abdominal sternite 3 without hooks ..... *uinta*
Respiratory filaments 20-26 (av. 25) arising from four or five main groups; abdominal sternite 3 with two hooks ..... *flaviantennus*

Keys to the Utah Species of *Cnephia*

Females

1. Claws simple; calcipala large and broadly rounded; mesopleural membrane bare ..... *mutata**
Claws each with a strong, thumb-like, basal projection; calcipala small; mesopleural membrane with a distinct patch of fine hair 2

2. Arms of genital rod widely separated, expanding into large, broad plates, each with a long, heavily sclerotized ridge on the antero-ventral margin from which arises a large, blunt tooth; median space of buccopharyngeal apparatus broad, shallow, U-shaped; maxilla with about 32 retrorse teeth ..... *jeanae*
Arms of genital rod more narrowly separated, expanding into long, narrow plates, each with a short, irregular, sclerotized ridge on the anteroventral margin from which arises a short, blunt, irregularly

5. The pupae of *P. longilobum* and *P. unicum* are not known

shaped tooth; median space of buccopharyngeal apparatus narrow, deep, U-shaped; maxilla with 22-26 retrorse teeth ..... *villosa*

Males

1. Mesopleural membrane bare; dististyle with two small, terminal spines ..... *mutata**
   Mesopleural membrane with a distinct patch of fine hair; dististyle with a single, small, terminal spine 2
2. Scutum anteriorly with erect or, at least, semi-erect hair; trough-like lip of ventral plate short, narrow basally and sharply pointed apically; parameral teeth fine and somewhat indistinct ..... *villosa*
   Scutum anteriorly with recumbent hair or, at most, with a few semi-erect hairs; trough-like lip of ventral plate longer, broader basally and more rounded apically; parameral teeth stout and distinct ..... *jeanae*

Pupae

1. Respiratory organ reddish, consisting of four stout, appressed, finger-like, primary stalks, each of which is covered dorsally with numerous short, fine, pale filaments ..... *villosa*
   Respiratory organ not so formed 2
2. Respiratory organ consisting of four moderately long, but often obscured, stalks that give rise to a series of smaller branches, each of which terminates in a number of slender, pale filaments, about 60-70 in all ..... *jeanae*
   Respiratory organ with 12 filaments occurring on two main branches, a dorsal with 7 filaments and a ventral branch with 5 filaments ..... *mutata**

Keys to the Utah Species of *Simulium*

Females

1. Vein R with hairs dorsally 2
   Vein R without hairs dorsally 8
2. Claws with a very small sub-basal tooth (visible only under high magnification); mandible and maxilla with fine hairs apically ..... *baffinense*
   Claws each with a strong, thumb-like, basal projection; mandible serrate; maxilla with retrorse teeth 3
3. Postscutellum with a patch of appressed, yellow hair (may be rubbed off); basal two segments of antenna pale yellowish-brown; legs bicolored ..... *aureum**
   Postscutellum bare; antenna and legs more uniformly brown 4
4. Arm of genital rod with a conspicuous internal spine-like process ..... *canonicolum*
   Arm of genital rod without a conspicuous internal spine-like process 5
5. Hair on stem vein yellow ..... *bicornis*
   Hair on stem vein dark 6
6. General body vestiture silvery-white; frons narrow, parallel sided or only slightly divergent above; distance from tip of one arm of genital rod to tip of other arm equal to or only slightly greater than length of stem ..... *wyomingensis*
   General body vestiture distinctly yellowish, frons narrow but sides distinctly divergent above; distance from tip of one arm of genital rod to tip of other arm considerably greater than length of stem 7
7. Legs brown, distal portion of each part darker; basitarsus of foreleg long and slender, 7-8 times as long as wide; large fly (3.0-3.5 mm.) .... *pugetense**
   Legs darker and uniformly brown; basitarsus of foreleg shorter and broader, 6 times as long as wide; smaller fly (2.0-3.0 mm.) ..... *latipes**

8. Claws simple 9
Claws with a large basal projection or a small sub-basal tooth 20
9. Frons and terminal abdominal tergites shining black or brown 10
Frons and terminal abdominal tergites distinctly pollinose 13
10. Fore coxa brown to black 11
Fore coxa yellow 12
11. Anal lobe bluntly pointed ventrally, extending noticeably below cercus, not produced posteriorly ..... *petersoni*
Anal lobe quadrate, extending below cercus only a short distance, produced slightly under cercus ..... ? *jacumbae*
12. Fore tibia with, at most, a narrow grayish-white streak on anterior surface covering not more than one-third the width of the tibia; small, dark fly (1.5-2.0 mm.) ..... *tuberosum**
Fore tibia with conspicuous, bright yellowish-white patch on anterior surface covering at least one-half the width of the tibia; lighter brown color; variable in size but usually about 2.5-3.0 mm. ..... *venustum**
13. Mesonotum unstriped, or the stripes very narrow and some of them not straight 14
Mesonotum with one or more distinct, rather broad, straight stripes; if one, it may be rather diffuse and not reach scutellum 17
14. Yellow to yellowish-gray species; thorax with almost no pattern; fore coxa yellow ..... *griseum*
Dark brown to black species; with or without a distinct black and light gray pattern on the thorax and abdomen; fore coxa variable 15
15. Abdomen blackish posteriorly, with a thin but distinct gray pollinosity; fore coxa yellow ..... *decorum*
Abdomen with a very distinct black and light gray pattern; fore coxa gray pollinose 16
16. Arms of genital rod each with a somewhat darkened external process, and a smaller and paler internal process that is removed from the one of the other side ..... *vittatum**
Arms of genital rod without external processes, but each with a large, pale, internal process rather close to the one of the other side ..... *argus*
17. Mesonotum with a single, rather broad, straight, orangish-brown stripe 18
Mesonotum with seven alternating stripes of contrasting color 19
18. Ventral margin of anal lobe drawn out into a long, slender, digitate process; abdominal tergite 2 without a centrally placed black spot, but with dark spots on tergites 3-6; legs mostly yellow, especially mesothoracic legs ..... *venator*
Ventral margin of anal lobe projecting below cercus but is shorter, and broader; abdominal tergite 2 with a centrally placed black spot in addition to those on tergites 3-6; legs more conspicuously bicolored ..... *mediovittatum*
19. Darker stripes on scutum orange; lateral dark spots on dorsum of abdomen absent or indistinct on most of the segments, never as prominent as the median dark sclerites; ventral projections of anal lobes not long enough to cross when in normal position ..... *bivittatum*
Darker stripes on scutum dark brown to blackish; dorsum of abdomen with pronounced, dark, lateral spots on several of the segments, nearly as dark as the median sclerites; ventral projections of anal lobes distinctly crossing each other when in normal position ..... *trivittatum*
20. Claws each with a large, thumb-like, basal projection 21
Claws each with a small sub-basal tooth 22
21. Frons and terminal abdominal tergites shining; fore coxa yellow .... *rugglesi*
Frons and terminal abdominal tergites gray pollinose; fore coxa dark ..... *meridionale*
22. Hair on stem vein pale 23
Hair on stem vein dark 25

23. Fore coxa dark; terminal abdominal tergites with a thin, gray pollinosity ..... *nigricoxum*
Fore coxa yellow; terminal abdominal tergites shining 24
24. Basal half of first flagellar segment of antenna yellow, distal half brown; legs mostly yellow, femora scarcely or not at all brown distally ..... *defoliarti*
First flagellar segment of antenna entirely brown; legs yellow but femora extensively darker ..... (common species) *arcticum* (rare species) *corbis*
25. Fore coxa dark ..... *piperi*
Fore coxa yellow 26
26. Frons grayish pollinose; scutum with two or seven stripes but never three; claws short, each with a small sub-basal tooth 27
Frons shining or sub-shining; scutum with three stripes, the median one straight and slender, the lateral ones curved and somewhat wider; claws long and slender, with a prominent sub-basal tooth ..... *hunteri*
27. Ovipositor flaps short, their inner margins concave; hairs of anal lobe short and slender; scutum black with two submedian stripes ..... *canadense*
Ovipositor flaps elongate, their inner margins subparallel; hairs of anal lobe long and stout; scutum with an orange tinge and seven stripes, although these are not always distinct ..... *virgatum*

Males[6]

1. Vein R with hairs dorsally 2
Vein R without hairs dorsally 8
2. Postscutellum with a patch of appressed, yellow hair (may be rubbed off); legs bicolored; ventral plate with a laterally compressed, median keel, basal arms narrow, widely divergent ..... *aureum**
Postscutellum bare; legs more uniformly brown; ventral plate without a laterally compressed, median keel 3
3. Dististyle tapering to a pointed apex 4
Dististyle obliquely angled apically, when viewed from end, showing a flattened, triangular area, one corner of this forming an inner lobe 5
4. Dististyle with a concavity on outside margin of apical one-half; ventral plate quadrate, shallowly concave on distal margin; hair on stem vein pale ..... *canonicolum*
Dististyle without a concavity on outside apical margin; ventral plate broadly V-shaped when viewed from dorsal aspect; hair on stem vein dark ..... *baffinense*
5. Ventral plate broad, with a medial V-shaped depression at the bottom of which is a prominent, hirsute, nipple-like ventral projection ..... *pugetense**
Ventral plate broad but without a medial V-shaped depression or prominent, nipple-like, ventral projection 6
6. Posterolateral margins of ventral plate with 2 or 3 shallow, notch-like folds or wrinkles ..... *bicornis*
Posterolateral margins of ventral plate smooth, without folds or wrinkles 7
7. Posterolateral margins of ventral plate rather truncate, the broad, hirsute central portion convexly triangular in shape and often projecting distally; dististyle viewed ventrally about twice as long as width at base; scutum with pale yellow hair on dorsal surface and a few silvery-white hairs on lateral margins ..... *wyomingensis*
Posterolateral margins of ventral plate rounded, the hirsute central portion narrower and shallowly concave on distal margin, without a triangular convexity; dististyle viewed ventrally about 2.5 times as long as width at base; scutum with golden-yellow hair on dorsal surface and a few dark hairs on posterior margin ..... *latipes**

6. The male of *S. nigricoxum* was not available for study and is not included in the key.

8. Dististyle short and stout with three or more apical spines 9
Dististyle longer, and/or with only one or two apical spines or none 10
9. Submedian white areas of scutum usually extending back as two distinct bands to the prescutellar white area; dististyle subquadrate, an obtuse rounded angle between the lateral and apical margins, apical spines small and set close together ..... *argus*
Submedian pale areas of scutum fading out before reaching prescutellar area; dististyle subtriangular, the apicolateral margin a continuous curve, apical spines larger and set farther apart ..... *vittatum**
10. The submedian white areas of scutum, visible in an anterior view, extending back to white prescutellar area ..... *trivittatum*
The submedian white areas, if present, not reaching white or denuded prescutellar area although the dark lines of an anterior view may be white when viewed posteriorly 11
11. Dististyle flat, quadrangular, with a distal internal angle more or less prolonged toward the median line; dististyle shorter than basistyle 12
Dististyle more or less cylindrical or, if flattened, distinctly longer than wide; dististyle longer than basistyle 15
12. Median area of scutum broadly orange except for anterior part ..... *venator*
Median area of scutum not orange 13
13. Thorax gray with a greenish tinge, without two anterior pollinose spots ..... *griseum*
Thorax darker, brown to black, with two anterior pollinose spots 14
14. Apex of ventral plate pointed; prothoracic and mesothoracic legs with extensive darkened areas ..... *mediovittatum*
Apex of ventral plate flattened or slightly rounded; prothoracic and mesothoracic legs yellow except for tarsi which are dark ..... *bivittatum*
15. Dististyle with lateral angles which give a sinuous appearance, not more than three times as long as wide; ventral plate rather broad, with a strong, narrow, median projection which is nearly one-half as long as dististyle, posterior margin slightly concave on each side of the median projection ..... *virgatum*
Dististyle with lateral margins more regular and/or ventral plate not so formed 16
16. Dististyle more than four times as long as wide, narrowed at basal third, without a basal process or pronounced angle; ventral plate semicircular in shape with a median notch ..... *canadense*
Dististyle not more than three times as long as wide, not narrowed at basal third, if longer, then a basal process present; ventral plate of various shapes but not semicircular 17
17. Dististyle with a stout spine, sclerotized lobe, or distinct tubercle at base internally 18
Dististyle without a stout spine or distinct tubercle at base internally 23
18. Base of dististyle with a rounded lobe internally, bearing short spines or fine hairs 19
Base of dististyle with a stout spine or horny projection internally 21
19. Basal lobe of dististyle with a number of short, stout spines ..... *tuberosum**
Basal lobe of dististyle with fine hairs only 20
20. Pleural tuft yellow; hind basitarsus about 5.3 times as long as greatest width; calcipala very small; apex of dististyle without a spine ..... *petersoni*
Pleural tuft brown; hind basitarsus about four times as long as greatest width; calcipala well developed; apex of dististyle with a single, rather large spine ..... *rugglesi*
21. Basal arms of ventral plate with short, lateral projections; apex of ventral plate hyaline, the sides set off by a notch, hairy ..... *piperi*
Basal arms of ventral plate without lateral projections; if apex of ventral plate is smooth and pale it is long and narrow 22
22. Ventral plate with a prolonged hyaline tip; base of dististyle with a broad, flattened, sclerotized lobe internally ..... *hunteri*

Ventral plate conical, without a prolonged hyaline tip; base of dististyle with a large, posteriorly directed lobe internally ..... *jacumbae*
23. Ventral plate broadly rounded, without denticles on margin ..... *meridionale*
Ventral plate more or less compressed laterally, with denticles on margin.. 24
24. Ventral plate narrow, in the shape of an inverted Y, with a ventral process or keel 25
Ventral plate broader, tooth-shaped, without a ventral process or keel ..... *venustum**
25. Ventral keel of ventral plate setose, forming an angle before apex of median portion of ventral plate ..... *decorum*
Ventral keel of ventral plate concave in profile, the angle being at the apex 26
26. Posteroventral angle of ventral plate forming a distinct bare projection beyond dentate portion; parameral hooks gradually lengthening toward the center ..... *corbis*
Posteroventral angle of ventral plate scarcely produced beyond dentate portion; parameral hooks consist of a few large ones intermingled with much smaller ones 27
27. Posteroventral angle of ventral plate pointed; base of keel ventrally with a short spine; legs with extensive darkened areas, especially on femora ..... *arcticum*
Posteroventral angle of ventral plate more truncate; base of keel ventrally without a spine; legs extensively yellow, femora without or with only scarcely darkened areas ..... *defoliarti*

Pupae[7]

1. Respiratory organ consisting of a large, annulate club and two curved, basal projections, one dorsal and one ventral ..... *canadense*
Respiratory organ consisting of slender, branched or unbranched filaments 2
2. Anterdorsal margin of cocoon with one or two long, median projections 3
Anterdorsal margin of cocoon without a long, median projection 6
3. Anterior margin of cocoon with two divergent projections; respiratory filaments 4 ..... *bicornis*
Anterior margin of cocoon with one median projection; number of respiratory filaments variable 4
4. Respiratory filaments 3 or 4 5
Respiratory filaments 9-13 ..... *piperi*
5. Respiratory filaments 3 ..... *baffinense*
Respiratory filaments 4 ..... *latipes**
6. Front of Cocoon with a broad collar set at a distinct angle to the surface on which the cocoon is placed so that the cocoon is boot-shaped 7
Front of cocoon with a narrow collar, raised little above the surface, or the anteroventral margins of the cocoon do not touch 11
7. Respiratory filaments 6 ..... *petersoni*
Respiratory filaments 8 or more 8
8. Respiratory filaments 8 ..... *virgatum*
Respiratory filaments more than 8 9
9. Respiratory filaments 10 ..... *corbis*
Respiratory filaments 12 10
10. Respiratory filaments evenly tapering from a swollen base, filaments spreading fan-like in a horizontal plane ..... *defoliarti*
Respiratory filaments narrow, spreading fan-like in a vertical plane ..... *arcticum*
11. Respiratory filaments 4 12
Respiratory filaments 6 or more 14
12. Dorsal respiratory filament strongly divergent at base from the

7. The pupae of *S. jacumbae*, *S. nigricoxum* and *S. venator* are not definitely known.

other three; dorsal pair of filaments on a short petiole, the ventral pair with almost no petiole ..... *aureum**
Dorsal respiratory filament not strongly divergent from the other three, however, the dorsal pair of filaments may be slightly divergent from the ventral pair; filaments occur in two petiolate pairs 13
13. Dorsal pair of filaments usually slightly divergent from the ventral pair; ventral pair of filaments on a long petiole; head and thorax of pupa with fine granules; pupa small (2.0-3.0 mm.) ..... *canonicolum*
Dorsal and ventral pairs of filaments lying close together; both pairs occur on short petioles of about equal length; head and thorax of pupa with coarse granules; pupa larger (3.5-4.5 mm.) ..... *pugetense**
14. Respiratory filaments 6 15
Respiratory filaments more than 6 16
15. Respiratory filaments all arising rather close to base ..... *tuberosum**
*venustum**
At least the median pair of filaments arising at a considerable distance from base ..... *trivittatum*
16. Respiratory filaments 8 17
Respiratory filaments more than 8 22
17. The dorsal filament widely diverging from the rest ..... *wyomingensis*
The dorsal filament not widely diverging from the rest 18
18. Cocoon tightly woven, with or without a thickened anterior rim; respiratory filaments in three main groups 19
Cocoon, especially anteriorly, loosely woven; respiratory filaments in in more than three groups 21
19. Thorax with conspicuous, long, forked or double trichomes; the three groups of filaments branching (2+1) + (2+1) + 2 (dorsal, medial, ventral), the dorsal group on short petioles, the medial and ventral groups on long petioles; anterior margin of cocoon with only a slightly thickened, narrow rim ..... *mediovittatum*
Thorax without trichomes, or with short, slender, inconspicuous trichomes; the three groups of filaments branching (2+1) + (1+2) + 2 (dorsal, medial, ventral); anterior margin of cocoon variable 20
20. Thorax without trichomes; filaments whitish, long and slender, the dorsal and medial groups on short petioles, the ventral group on a long petiole; anterior margin of cocoon with only a slightly thickened, narrow rim ..... *griseum*
Thorax with small trichomes; filaments shorter and thicker, branching fan-like near base of short petioles; anterior margin of cocoon broader and distinctly thickened ..... *bivittatum*
21. Respiratory filaments thick, in three short-petiolate pairs, plus two singly ..... *decorum*
Respiratory filaments thin, in four petiolate pairs ..... *rugglesi*
22. Respiratory filaments 10 ..... *argus*
Respiratory filaments more than 10 23
23. Respiratory filaments 14-16 ..... *vittatum**
Respiratory filaments more than 16 24
24. Respiratory filaments 22-26 ..... *meridionale*
Respiratory organ a dense tuft of 100 or more fine filaments ..... *hunteri*

Original Citations, Types and Distribution

Twinnia nova (Dyar and Shannon)

Prosimulium novum Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69(10):5-6, figs. 14-15 (female).

Cotypes.—Two females, Cat. No. 28325, U. S. National Museum.

Type locality.—Two Medicine Lake, Montana, July 4, 1921 (H. G. Dyar).

Distribution.—UTAH: Only one female with no data other than a "Utah" locality label was available for study from the state. However, no differences could be found in comparison with specimens examined from other western regions.

Previous Records[8]. British Columbia; California; Idaho; Montana; Washington.

Prosimulium (*Helodon*) *onychodactylum* Dyar and Shannon

Prosimulium onychodactylum Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69(10):4, figs. 10-11 (female).

Holotype.—Female, Cat. No. 28324, U. S. National Museum.

Type locality.—Long's Peak, Colorado, timberline, elevation 11,000 feet, August 28 (T.D.A. Cockrell).

Distribution.—UTAH: 4,250 - 9,600 feet. Box Elder, Cache, Morgan, Salt Lake, Summit, Wasatch, and Washington Counties. NEW RECORDS: OREGON: Hood River Co., East Fork of Hood River, August 29, 1954 (R. K. Allen) (larvae); East Fork of Hood River at Sahalie Falls, August 31, 1958 (G. F. Edmunds and R. K. Allen) (larvae, pupae). WASHINGTON: Skamania Co., stream near Cultus Creek Forest Camp, Mt. Adams area, August 31, 1958 (G. F. Edmunds and R. K. Allen) (larvae). Yakima Co., American River at Lodgepole Forest Camp, September 5, 1958 (G. F. Edmunds and R. K. Allen) (larvae). PREVIOUS RECORDS: Alaska; British Columbia; California; Colorado; New Mexico; Wyoming; Yukon Territory.

Prosimulium (*Prosimulium*) *daviesi* Peterson and DeFoliart

Prosimulium daviesi Peterson and DeFoliart, 1960, Can. Ent. 92:85-91, figs. 1-12 (female, male, pupa, larva).

Holotype.—Female, U. S. National Museum.

Type locality.—Small stream 19.3 miles up Logan Canyon, Cache Co., Utah, elevation 6,200 feet, May 26, 1957 (B. V. Peterson).

Distribution.—UTAH: 6,200 - 10,050 feet. Cache, Duchesne, Morgan and Summit Counties. PREVIOUS RECORDS: Wyoming.

Prosimulium (*Prosimulium*) *exigens* Dyar and Shannon

Prosimulium exigens Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69(10):10, figs. 3-4, 30-31 (female, male).

Cotypes.—Two males, Cat. No. 28329, U. S. National Museum.

Type locality.—Moscow, Idaho (J. M. Aldrich).

Distribution.—UTAH: 4.200 - 11,000 feet. Box Elder, Cache, Duchesne, Garfield, Grand, Iron, Juab, Kane, Millard, Morgan, Salt Lake, Sanpete, Summit, Wasatch, Washington and Weber Counties. NEW RECORDS: ARIZONA: Gila Co., Tonto Creek, Tonto National Forest, June 2, 1937 (C. M. Tarzwell) (larvae, pupae). Mohave Co., small stream about 10 miles west of Highway 91, and 5 miles south

8. These records include only those from western North America which is arbitrarily defined to include Alaska, Alberta, Arizona, British Columbia, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, Yukon Territory.

of the Utah-Arizona border, March 17, 1956 (B. V. Peterson) (larvae). NEVADA: Douglas Co., Gardnerville, elevation 6,000, June 24, 1958 (D. M. Wood) (adults). Lincoln Co., 6 miles north Alamo, May 7, 1955 (B. V. Peterson) (larvae, pupae); 2 miles north Caliente, May 7, 1955 (B.V. Peterson) (larvae, pupae). PREVIOUS RECORDS: British Columbia; California; Colorado; Idaho; Montana; Oregon; Washington; Wyoming.

Prosimulium (*Prosimulium*) *flaviantennus* (Stains and Knowlton)

Simulium (*Eusimulium*) *flaviantennus* Stains and Knowlton, 1940, Ann. Ent. Soc. Amer. 33:79-80, figs. E, H (female).

Holotype.—Female, U. S. National Museum.

Type locality.—Logan Canyon, Cache Co., Utah, July 10, 1938 (D. E. Hardy and A. T. Hardy).

Distribution.—UTAH: 2,700 - 7,000 feet. Cache, Millard, Salt Lake, Summit, Wasatch and Washington Counties. NEW RECORDS: IDAHO: Lawyer's Canyon. MONTANA: Two Medicine River. PREVIOUS RECORDS: Colorado; Wyoming.

Prosimulium (*Prosimulium*) *fulvum* (Coquillett)

Simulium fulvum Coquillett, 1902, Proc. U. S. Nat. Mus. 25:96 (female, male).

Holotype.—Male, Cat. No. 6182, U. S. National Museum.

Type locality.—Bear Paw Mountains, Montana, September 3, 1891 (H. G. Hubbard).

Distribution.—UTAH: 6,000 - 10,050 feet. Cache and Duchesne Counties. PREVIOUS RECORDS: Alaska; British Columbia; California; Colorado; Idaho; Montana; Oregon; Washington; Wyoming; Yukon Territory.

Prosimulium (*Prosimulium*) *longilobum* Peterson and DeFoliart

Prosimulium longilobum Peterson and DeFoliart, 1960, Can. Ent. 92:100-102, figs. 32-34 (female).

Holotype.—Female, U. S. National Museum.

Type locality.—Mirror Lake, Duchesne Co., Utah, elevation 10,050 feet, July 26, 1952 (L. T. Nielsen).

Prosimulium (*Prosimulium*) *shewelli* Peterson and DeFoliart

Prosimulium shewelli Peterson and DeFoliart, 1960, Can. Ent. 92:96-100, figs. 22-31 (female, male, pupa, larva).

Holotype.—Female, U. S. National Museum.

Type locality.—Small stream crossing Highway 89-287, 7 miles north of Leeks Lodge, Teton Co., Wyoming, June 16, 1958 (G. R. DeFoliart).

Distribution.—UTAH: 8,800 feet. Wasatch Co. PREVIOUS RECORDS: Wyoming.

Prosimulium (*Prosimulium*) *travisi* Stone

Prosimulium travisi Stone, 1952, Proc. Ent. Soc. Wash. 54:76-77 (female, male, pupa).

Holotype.—Female, Cat. No. 61188, U. S. National Museum.

Type locality.—Anchorage, Alaska, September 30, 1948 (Sommerman and Dover).

Distribution.—UTAH: 10,050 feet. NEW RECORD: Duchesne Co., 3 miles northeast of Mirror Lake, June 27, 1958 (B. V. Peterson) (larvae, pupae with nearly mature adults). PREVIOUS RECORDS: Alaska; British Columbia; California; Colorado; Yukon Territory.

Prosimulium (*Prosimulium*) *uinta* Peterson and DeFoliart

Prosimulium uinta Peterson and DeFoliart, 1960, Can. Ent. 92:91-96. figs. 13-21 (female, male, pupa, larva).

Holotype.—Male, U. S. National Museum.

Type locality.—Sweeney Creek, Skyline Drive, mile 8.4, Pinedale, Sublette Co., Wyoming, June 26, 1957 (G. R. DeFoliart).

Distribution.—UTAH: 7,000 feet. Summit Co. PREVIOUS RECORDS: Wyoming.

Prosimulium (*Prosimulium*) *unicum* (Twinn)

Simulium (*Prosimulium*) *unicum* Twinn, 1938, Can. Ent. 70:49, figs. 1a, 1b (female).

Holotype.—Female, No. 4447, Canadian National Collection.

Type locality.—Morgan, Morgan Co., Utah, elevation 5,068 feet, May 6, 1937 (G. F. Knowlton).

Cnephia (*Cnephia*) *jeanae* DeFoliart and Peterson

Cnephia jeanae DeFoliart and Peterson, 1960, Ann. Ent. Soc. Amer. 53:218-219, figs. 15-25 (female, male, pupa, larva).

Holotype.—Male, U. S. National Museum.

Type locality.—Chalk Creek Canyon, Summit Co., Utah, elevation 7,000 feet, June 15, 1958 (B. V. Peterson).

Distribution.—UTAH: Summit Co. PREVIOUS RECORDS: Wyoming.

Cnephia (*Cnephia*) *villosa* DeFoliart and Peterson

Cnephia villosa DeFoliart and Peterson, 1960. Ann. Ent. Soc. Amer. 53:213-216, figs. 1-12 (female, male, pupa, larva).

Holotype.—Male, U. S. National Museum.

Type locality.—Sweeney Creek adjacent to Skyline Drive, 10 miles north of Pinedale, Sublette Co., Wyoming, elevation approximately 8,000 feet, June 26, 1957 (G. R. DeFoliart).

Distribution.—UTAH: 6,500 - 7,000 feet. Summit Co. PREVIOUS RECORDS: Wyoming.

Cnephia (*Stegopterna*) *mutata* (Malloch)

Prosimulium mutatum Malloch, 1914, U. S. Dept. Agr., Bur. Ent., Tech. Ser. 26:20-21, fig. 18 (female).

Holotype.—Female, Cat. No. 15404, U. S. National Museum.

Type locality.—Glassboro, New Jersey, March 28, 1910 (C. T. Greene).

Distribution.—UTAH: 6,500 - 11,000 feet. Duchesne, Salt Lake, Summit and Utah Counties. PREVIOUS RECORDS: Alaska; British Columbia; California; Idaho; Montana; Washington; Wyoming.

Simulium (*Eusimulium*) *aureum* Fries

Simulia aurea Fries, 1824, Observationes Entomologicae 1:16 (male, female).

Cotypes.—(?) Two females, Zoological Institute, University of Lund, Lund, Sweden.

Type locality.—The types were collected by Zetterstedt in Scania, Sweden, from Esperöd and Björnstorp.

Distribution.—UTAH: 2,625 - 11,000 feet. Beaver, Box Elder, Cache, Carbon, Daggett, Davis, Duchesne, Garfield, Kane, Morgan, Piute, Salt Lake, Summit, Utah, Wasatch, Washington and Weber Counties. PREVIOUS RECORDS: Alaska; Alberta; British Columbia; California; Colorado; Idaho; Nevada; Oregon; Washington; Wyoming; Yukon Territory.

Simulium (*Eusimulium*) *baffinense* Twinn

Simulium (*Eusimulium*) *baffinense* Twinn, 1936, Can. Jour. Res., D, 14:121-123, figs. 8A, 1-5 (female, male).

Holotype.—Female, No. 4126, Canadian National Collection.

Type locality.—Lake Harbour, Baffin Island, August 10, 1935 (W. J. Brown).

Distribution.—UTAH: 6,000 feet. Cache Co. PREVIOUS RECORDS: Alaska; Yukon Territory.

Simulium (*Eusimulium*) *bicornis* Dorogostajskij, Rubtzov and Vlasenko

Simulium bicornis Dorogostajskij, Rubtzov and Vlasenko, 1935, Zool. Inst., Acad. Sci., Mag. Parasitol. 5:178-180, figs. 1-8 (female, male, pupa, larva).

Holotype.—The sex of the type specimen is unknown to the writer; however, the type specimens are in the collection of the Museum of the Irkutsk Biologico-Geographical Scientific Research Institute, Irkutsk, U.S.S.R.

Type locality.—The following is a literal translation of the Russian from the original publication: "Rare form. Alone in two taiga (forest) streams; Mol'ke, Balag. river 10 V1 1931, larvae 10 examined, pupae 12 examined. ♂ ♂, 2 examined. ♀ ♀ - 3 examined, and in a spring beyond 3 railroad siding (Angara river near Pashkovo) 21 V111 1931 (pupae)."

Distribution.—UTAH: 5,500 - 7,000 feet. Salt Lake and Summit Counties. PREVIOUS RECORDS: Alaska.

Simulium (*Eusimulium*) *canonicolum* (Dyar and Shannon)

Eusimulium canonicolum Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69(10):22, fig. 40 (female).

Holotype.—Female, Cat. No. 28337, U. S. National Museum.

Type locality.—Yellowstone Canyon, Wyoming, July 3, 1922 (H. G. Dyar).

Distribution.—UTAH: 4,679-10,050 feet. Cache, Salt Lake, Summit and Wasatch Counties. PREVIOUS RECORDS: British Columbia; California; Colorado; Idaho; Montana; Nevada; Oregon; Wyoming.

Simulium (*Eusimulium*) *latipes* (Meigen)

Atractocera latipes Meigen, 1804, Klassif. Beschr. Europaischen Zweiflüg. Insekten 1:96 (male).

Holotype.—Male (location not known to author).

Type locality.—Not known to author.

Distribution.—UTAH: 4,725 - 10,050 feet. Duchesne, Morgan, Salt Lake, Summit and Weber Counties. PREVIOUS RECORDS: Alaska; California; Wyoming; Yukon Territory.

Simulium (*Eusimulium*) *pugetense* (Dyar and Shannon)

Eusimulium pugetense Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69(10):23, figs. 121-123 (male).

Holotype.—Male, Cat. No. 28338, U. S. National Museum.

Type locality.—Seattle, Washington (C. V. Piper).

Distribution.—UTAH: 5,000 - 9,936 feet. Cache, Morgan, Salt Lake, Summit and Weber Counties. PREVIOUS RECORDS: Alaksa; Alberta; British Columbia; California; Washington; Yukon Territory.

Simulium (*Eusimulium*) *wyomingensis* Stone and DeFoliart

Simulium (*Eusimulium*) *wyomingensis* Stone and DeFoliart, 1959, Ann. Ent. Soc. Amer. 52:395, 398-400, figs. 15-28 (female, male, pupa, larva).

Holotype.—Male, U. S. National Museum.

Type locality.—McGill Ranch irrigation ditch, Little Laramie River Valley, Albany Co., Wyoming, June 10, 1957 (G. R. DeFoliart).

Distribution.—UTAH: 5,675 - 7,000 feet. NEW RECORD: San Juan Co., Dry Wash, Coyote Gulch, July 26, 1957 (B. Quinn and R. Groosman) (pupae). Summit Co., Chalk Creek Canyon, June 2, 1956 (B. V. Peterson) (pupae, adults). PREVIOUS RECORDS: Wyoming.

Simulium (*Byssodon*) *meridionale* Riley

Simulium meridionale Riley, 1887, Rept. Ent. U. S. Dept. Agr. for 1886:513, fig. 6 (female).

Holotype.—Female, Cat. No. 773, U. S. National Museum.

Type locality.—Probably Lake View, Mississippi, March 16, 1886.

Distribution.—UTAH: 4,418 feet, Cache Co. PREVIOUS RECORDS: Alaska; Alberta; California; Colorado; Idaho; Montana; New Mexico.

Simulium (*Byssodon*) *rugglesi* Nicholson and Mickel

Simulium rugglesi Nicholson and Mickel, 1950, Univ. Minn. Agr. Expt. Station, Tech. Bull. 192:60-61, figs. 23A, B (female).

Holotype.—Female, University of Minnesota.

Type locality.—Todd County, Minnesota, June 24, 1937.

Distribution.—UTAH: 10,050 feet, Summit Co. PREVIOUS RECORDS: Alaska.

Simulium (*Gnus*) *arcticum* Malloch

Simulium arcticum Malloch, 1914, U. S. Dept. Agr., Bur. Ent., Tech. Ser. 26:37, fig. 4 (female).

Holotype.—Female, Cat. No. 15410, U. S. National Museum.

Type locality.—Kaslo, British Columbia, July 4 (H. G. Dyar).

Distribution.—UTAH: 2,625 - 10,050 feet. Beaver, Box Elder, Cache, Daggett, Davis, Duchesne, Emery, Garfield, Iron, Juab, Kane, Millard, Morgan, Piute, Salt Lake, Sanpete, Sevier, Summit, Uintah, Utah, Wasatch, Washington, Wayne and Weber Counties. NEW RECORD: ARIZONA: Gila Co., Tonto Creek, Tonto National Forest, June 2, 1937 (C. M. Tarzwell) (larvae, pupae). PREVIOUS RECORDS: Alaska; Alberta; British Columbia; California; Colorado; Idaho; Montana; Nevada; New Mexico; Oregon; Washington; Wyoming; Yukon Territory.

Simulium (*Gnus*) *corbis* Twinn

Simulium (*Simulium*) *corbis* Twinn, 1936, Can. Jour. Res., D, 14:147-148, figs. 15B, 1-5 (female, male, pupa).

Holotype.—Female, No. 4131, Canadian National Collection.

Type locality.— Blanch River, about five miles south of Perkins, Quebec, May 26, 1935 (C. R. Twinn).

Distribution.—UTAH: 4,302 - 6,289 feet. Cache, Davis, Grand, Rich and Utah Counties. PREVIOUS RECORDS: Alaska, Alberta; British Columbia; Idaho; Yukon Territory.

Simulium (*Gnus*) *defoliarti* Stone and Peterson

Simulium defoliarti Stone and Peterson, 1958, Bull. Brooklyn Ent. Soc. 53:1-6, figs. 1-17 (female, male, pupa, larva).

Holotype.—Female, Cat. No. 63961, U. S. National Museum.

Type locality.—Smith's Fork Creek at Lander Trail, 8.5 miles from Smoot entrance, Lincoln Co., Wyoming, August 11, 1956 (G. R. DeFoliart).

Distribution.—UTAH: 4,500 - 8,730 feet. Cache and Salt Lake Counties. NEW RECORD: NEW MEXICO: Taos Co., Red River at west fork, Carson National Forest, July 27, 1937 (C. M. Tarzwell) (larvae, pupae). PREVIOUS RECORDS: British Columbia; California; Montana; Washington; Wyoming.

Simulium (*Gnus*) *nigricoxum* Stone

Simulium nigricoxum Stone, 1952, Proc. Ent. Soc. Wash. 54:94-95 (female).

Holotype.—Female, No. 1147, Canadian National Collection.

Type locality.—Hood River, Arctic Sound, Northwest Territories, August 28, 1915 (R. M. Anderson).

Distribution.—UTAH: 9,000 - 10,050 feet. Summit Co. PREVIOUS RECORDS: Alaksa; Yukon Territory.

Simulium (*Hearlea*) *canadense* Hearle

Simulium virgatum canadensis Hearle, 1932, Proc. Ent. Soc. British Columbia 29:14-15 (female, male).

Holotype.—Male, No. 3454, Canadian National Collection.

Type locality.—Lanes Creek, Kamloops, British Columbia, August 6, 1931 (T. K. Moilliett and R. T. Turner).

Distribution.—UTAH: 4,302 - 10,050 feet. Cache, Davis, Juab, Kane, Morgan, Salt Lake, Summit, Wasatch, Washington, Wayne and Weber Counties. NEW RECORDS: ARIZONA: ? Gila Co., Middle Horton Creek, October 11, 1937 (C. M. Tarzwell) (larvae, pupae). Lower Horton Creek, October 12, 1937 (C. M. Tarzwell) (pupae). IDAHO: Idaho Co., Rapid River at junction with Little Salmon River, 5 miles north Pollock, September 6, 1958 (G. F. Edmunds and R. K. Allen) (larvae). WASHINGTON: Grays Harbour Co., tributary, East Fork Humptulips River, near Twinn Peak, September 2, 1958 (G. F. Edmunds and R. K. Allen) (larvae). Kitsap Co., Big Quilcene River on Highway 101, September 9, 1958 (G. F. Edmunds and R. K. Allen) (larvae, pupae). Okanogan Co., 10 miles east Tonasket, Highway 41, July 29, 1958 (G. F. Edmunds) (larvae, pupae). PREVIOUS RECORDS: British Columbia; California; Colorado; Montana; Nevada; New Mexico; Oregon; Wyoming.

Simulium (*Hemicnetha*) *virgatum* Coquillett

Simulium virgatum Coquillett, 1902, Proc. U. S. Nat. Mus. 25:97 (female, male).

Holotype.—Male, Cat. No. 6183, U. S. National Museum.

Type locality.—Las Vegas Hot Springs, New Mexico, August 4 (H. S. Barber).

Distribution.—UTAH: 2,750 - 5,000 feet. Garfield, Grand, Juab, Kane, San Juan, Tooele, Utah, and Washington Counties. NEW RECORDS: ARIZONA: Coconino Co., Oak Creek Canyon, July 2, 1958 (D. M. Wood) (larvae, pupae, adults). Gila Co., Tonto Creek, Tonto National Forest, June 2, 1937 (C. M. Tarzwell) (larvae, pupae). PREVIOUS RECORDS: California; New Mexico; Oregon; Washington.

Simulium (*Neosimulium*) *argus* Williston

Simulium argus Williston, 1893, North American Fauna 7:253-254 (female).

Holotype.—Female, University of Kansas.

Type locality.—Argus Mountains, California, May, 1891.

Distribution.—UTAH: 3,654 - 6,587 feet. Beaver, Cache, Davis, Juab, Kane, Salt Lake, San Juan, Summit, Uintah, Wasatch, and Washington Counties. NEW RECORDS: NEVADA: Lincoln Co., 2 miles north Caliente, May 7, 1955 (B. V. Peterson) (larvae, pupae); 6 miles north Alamo, May 7, 1955 (B. V. Peterson) (larvae, pupae, adults). OREGON: Grant Co., Dayville, June 16, 1958 (D. M. Wood) (adults). PREVIOUS RECORDS: Arizona; British Columbia; California; Idaho; New Mexico; Washington; Wyoming.

Simulium (*Neosimulium*) *vittatum* Zetterstedt

Simulia vittata Zetterstedt, 1838, Insecta Lapponica Descripta, page 803 (female).

Holotype.—A single female from Greenland, presumably the holotype, is in the Zetterstedt collection at the University of Lund, Lund, Sweden.

Type locality.—Greenland.

Distribution.—UTAH: 2,750 - 11,000 feet. Beaver, Box Elder, Cache, Carbon, Daggett, Davis, Duchesne, Emery, Garfield, Grand, Iron, Juab, Kane, Millard, Morgan, Piute, Rich, Salt Lake, San Juan, Sanpete, Sevier, Summit, Tooele, Uintah, Utah, Wasatch, Washington, Wayne and Weber Counties. PREVIOUS RECORDS: Alaska; Alberta; Arizona; British Columbia; California; Colorado; Idaho; Montana; Nevada; New Mexico; Oregon; Washington; Wyoming; Yukon Territory.

Simulium (*Psilopelmia*) *bivittatum* Malloch

Simulium bivittatum Malloch, 1914, U. S. Dept. Agr., Bur. Ent., Tech. Ser. 26:31-32, fig. 7 (female).

Holotype.—Female, Cat. No. 15415, U. S. National Museum.

Type locality.—East Las Vegas, New Mexico, June 1, 1901 (T.D.A. Cockrell).

Distribution.—UTAH: 2,625 - 5,650 feet. Box Elder, Cache, Garfield, Kane, Morgan, Salt Lake, Summit, Wasatch, Washington, Wayne and Weber Counties. NEW RECORD: ARIZONA: Mohave Co., small stream along Highway 91 about 10 miles south Utah-Arizona border, March 18, 1956 (B. V. Peterson) (larvae, pupae, adults).

PREVIOUS RECORDS: Alberta; California; Colorado; Idaho; Montana; New Mexico; Washington; Wyoming.

Simulium (*Psilopelmia*) *griseum* Coquillett

Simulium griseum Coquillett, 1898, U. S. Dept. Agr., Div. Ent., N. S., Bull. 10:69 (female, male).

Holotype.—Male, Cat. No. 10381, U. S. National Museum.

Type locality.—Colorado (C. F. Baker)

Distribution.—UTAH: 2,625 - 7,750 feet. Daggett, Duchesne, Grand, San Juan, Wasatch, and Washington Counties. PREVIOUS RECORDS: Alberta; California; Colorado; Montana; New Mexico.

Simulium (*Psilopelmia*) *mediovittatum* Knab

Simulium mediovittatum Knab, 1916, Ins. Insc. Mens. 3:77-78 (female).

Holotype.—Female, Cat. No. 19635, U. S. National Museum.

Type locality.—Arlington, Texas, October 28, 1914 (F. C. Bishopp).

Distribution.—UTAH: 3,265 - 4,490 feet. Cache and Kane Counties.

Simulium (*Psilopelmia*) *trivittatum* Malloch

Simulium trivittatum Malloch, 1914, U. S. Dept. Agr., Bur. Ent., Tech. Ser. 26:30 (female).

Holotype.—Female, Cat. No. 15408, U. S. National Museum.

Type locality.—Tampico, Mexico, December 17 (E. A. Schwarz).

Distribution.—UTAH: 5,418 - 6,000 feet. Grand, Wasatch, and Wayne Counties. NEW RECORD: MONTANA: Gallatin Co., West Yellowstone, June 8, 1956 (T. Morledge) (adults). PREVIOUS RECORDS: Arizona; California.

Simulium (*Psilopelmia*) *venator* Dyar and Shannon

Simulium venator Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69 (10):36, figs. 92-93 (female, male).

Holotype.—Female, Cat. No. 28343, U. S. National Museum.

Type locality.—Reno, Nevada, July 7, 1916 (H. G. Dyar).

Distribution.—UTAH: 4,270 - 4,500 feet. Cache, Morgan, and Washington Counties. PREVIOUS RECORDS: California; Idaho; Montana; Nevada; Oregon.

Simulium (*Simulium*) *decorum* Walker

Simulium decorum Walker, 1848, List Diptera British Museum 1:112 (female).

Holotype.—Female, British Museum, London. England.

Type locality.—St. Martin's Falls, Albany River, Ontario (G. Barnston).

Distribution.—UTAH: 8,730 - 10,050 feet. Salt Lake, Summit, and Wasatch Counties. NEW RECORDS: WASHINGTON: Jefferson Co., North Fork of Quinalt River at junction with Quinalt River, Olympic National Park, September 3, 1958 (G. F. Edmunds and R. K. Allen) (larvae). Pierce Co., Fort Lewis, June 25, 1957 (B. V. Peterson) (adults). PREVIOUS RECORDS: Alaska; Alberta; British Columbia; Colorado; Montana; Yukon Territory.

Simulium (*Simulium*) *hunteri* Malloch

Simulium hunteri Malloch, 1914, U. S. Dept. Agr., Bur. Ent., Tech. Ser. 26:59-60, fig. 3 (female).

Holotype.—Female, Cat. No. 15413, U. S. National Museum.

Type locality.—Virginia Dale, Colorado, September 30, 1912 (Bishopp).

Distribution.—UTAH: 4,679 - 10,050 feet. Cache, Duchesne, Salt Lake, Summit, and Wasatch Counties. NEW RECORDS: IDAHO: Shoshone Co., Wallace, September 3, 1949 (S. and D. Mulaik) (larvae, pupae, adults). WASHINGTONS Mason Co., Eldon, June 14, 1958 (D. M. Wood) (larvae, pupae). PREVIOUS RECORDS: Alaska; Alberta; British Columbia; California; Colorado; Montana; New Mexico; Wyoming; Yukon Territory.

Simulium (*Simulium*) *jacumbae* Dyar and Shannon

Simulium jacumbae Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69 (10): 44-45, figs 113-114 (male).

Holotype. Male, Cat. No. 28348, U. S. National Museum.

Type locality. Jacumba Springs, California (E. A. McGregor).

Distribution.—UTAH: 2,625 - 10,050 feet. Summit and Washington Counties. PREVIOUS RECORDS: California; Colorado.

Simulium (*Simulium*) *petersoni* Stone and DeFoliart

Simulium (*Simulium*) *petersoni* Stone and DeFoliart, 1959, Ann. Ent. Soc. Amer. 52:394-395, figs. 1-14 (female, male, pupa, larva).

Holotype.—Male, U. S. National Museum.

Type locality.— School Creek - N. Sybille Creek confluence, Albany Co., Wyoming, June 18, 1956 (G. R. DeFoliart).

Distribution.—UTAH: 4,500 - 10,050 feet. Cache, Garfield, Iron, Morgan, Salt Lake, Summit, and Wasatch Counties. PREVIOUS RECORDS: California; Washington; Wyoming.

Simulium (*Simulium*) *piperi* Dyar and Shannon

Simulium piperi Dyar and Shannon, 1927, Proc. U. S. Nat. Mus. 69(10):38-39, figs. 129-130 (male).

Holotype—Male, Cat. No. 28344, U. S. National Museum.

Type locality.—Seattle, Washington (C. V. Piper).

Distribution.—Utah: 2,750-9,936 feet. Beaver, Box Elder, Cache, Davis, Duchesne, Grand, Morgan, Piute, Salt Lake, San Juan, Sanpete, Summit, Wasatch, Washington, and Weber Counties. New Records: Arizona: Gila Co., Upper Horton Creek, Apache National Forest, October 9, 1937 (C. M. Tarzwell) (larvae). Previous Records: Alberta; British Columbia; California; Colorado; Idaho; Washington.

Simulium (*Simulium*) *tuberosum* (Lundström)

Melusina tuberosa Lundström, 1911, Acta. Soc. Fauna Flora Fenn. 34:14-15, fig. 10 (male).

Holotype.—Male (location not known to the author).

Type locality.—Probably Enontekis (Enontekiö), Finnish Lapland, Finland.

Distribution.—Utah: 4,253 - 10,050 feet. Cache, Duchesne, Garfield, Juab, Morgan, Salt Lake, Sanpete, Summit, Wasatch, Washington, Wayne and Weber Counties. New Records: Arizona: Coconino Co., Little Colorado River, June 29, 1937 (C. M. Tarzwell) (larvae, pupae). Idaho: Custer Co., Big Lost River, Mackay, July 15, 3 miles south Genoa, September 21, 1957 (G. F. Edmunds and R. K. 1957 (G. F. Edmunds) (larvae). Nevada: Douglas Co., Haines Creek, Allen) (larvae). New Mexico: San Miguel Co., Gallinas River, Santa Fe National Forest, July 16, 1937 (C. M. Tarzwell) (larvae, pupae). Washington: Grays Harbor Co., Humptulips River at Humptulips, September 2, 1958 (G. F. Edmunds and R. K. Allen) (larvae, pupae). Kitsap Co., Big Quilcene River on Highway 101, September 4, 1958 (G. F. Edmunds and R. K. Allen) (larvae, pupae). Previous Records: Alaska; Alberta; British Columbia; California; Wyoming; Yukon Territory.

Simulium (*Simulium*) *venustum* Say

Simulium venustum Say, 1823. Jour. Acad. Natur. Sci. Philadelphia 3:28-29 (female, male).

Holotype.—Female, type probably lost.

Type locality.—Shippingsport, Ohio, collection date was between May 5 and June 9.

Distribution.—Utah: 4,253 - 8,150 feet. Cache, Morgan, Salt Lake, Summit, Washington, and Weber Counties. Previous Records: Alaska; Alberta; British Columbia; California; Colorado; Idaho; Montana; Washington; Wyoming; Yukon Territory.

Acknowledgements

I wish to express my thanks to the following specialists of the Family Simuliidae, for reading the manuscript and making valuable suggestions: Dr. A. Stone, Insect Identification and Parasite Introduction Research Branch, United States Department of Agriculture, Washington, D. C.; Mr. G. E. Shewell, Entomology Research Insti-

tute, Research Branch, Canada Department of Agriculture, Ottawa, Ontario; Dr. D. M. Davies and Mr. D. M. Wood, Department of Biology, McMaster University, Hamilton, Ontario; Dr. G. R. DeFoliart, Department of Entomology, University of Wisconsin, Madison Wisconsin. I am indebted to Dr. G. F. Edmunds, Jr. and Dr. R. K. Allen, Department of Zoology, University of Utah, Salt Lake City, Utah, for providing many specimens. To Dr. C. H. Lindroth, Zoological Institute, University of Lund, Lund, Sweden, and Dr. K. J. Heqvist, Department of Entomology, Swedish Museum of Natural History, Stockholm, Sweden, I am grateful for information on type specimens in the Zetterstedt and Fries collections respectively.

Literature Cited

DeFoliart, G. R. and B. V. Peterson. 1960. New North American Simuliidae of the genus *Cnephia* Enderlein (Diptera). Ann. Ent. Soc. Amer. 53:213-219.

Lugger, O. 1896. Simuliidae *in* Insects injurious in 1896. Univ. Minn. Agr. Expt. Sta., Ent. Div. Bull. 48:198-208.

Millar, J. L. and J. G. Rempel. 1944. Live stock losses in Saskatchewan due to blackflies Can. J. Comp. Med. 8:334-337.

Peterson, B. V. 1955. A preliminary list of the black flies (Diptera:Simuliidae) of Utah. Proc. Utah Acad. Sci., Arts, and Letters 32:113-115.

Peterson, B. V. 1956. Observations on the biology of Utah black flies (Diptera:Simuliidae). Can. Ent. 88:496-507.

Peterson, B. V. 1958. A redescription of the female and first descriptions of the male, pupa and larva of *Prosimulium flaviantennus* (S. and K.) with notes on the Biology and distribution. Can. Ent. 90:469-473.

Peterson, B. V. 1959a. Three new black fly records from Utah (Diptera, Simuliidae). Proc. Ent. Soc. Wash. 61:21.

Peterson, B. V. 1959b. Observations on mating, feeding, and oviposition of some Utah species of black flies (Diptera:Simuliidae). Can. Ent. 91:147-155.

Peterson, B. V. 1959c. Notes on the biology of some species of Utah blackflies (Diptera:Simuliidae). Mosquito News 19:86-90.

Peterson, B. V. 1960. Notes on some natural enemies of Utah black flies (Diptera:Simuliidae). Can. Ent. 92:266-274.

Peterson, B. V. and G. R. DeFoliart. 1960. Four new species of *Prosimulium* (Diptera:Simuliidae) from western United States. Can. Ent. 92:85-102.

Rempel, J. G. and A. P. Arnason. 1947. An account of three successive outbreaks of the black fly, *Simulium arcticum*, a serious livestock pest in Saskatchewan. Scientific Agr. 27:428-445.

Riley, C. V. 1887. Simuliidae *in* Report of the Entomologist. Report of the Commissioner of Agriculture for 1886:492-517.

Stone, A. and G. R. DeFoliart. 1959. Two new black flies from the western United States (Diptera:Simuliidae) Ann. Ent. Soc. Amer. 52:394-400.

Stone, A. and H. A. Jamnback. 1955. The black flies of New York State (Diptera:Simuliidae). N. Y. State Mus. Bull. 349: 1-144.

Stone, A. and B. V. Peterson. 1958. *Simulium defoliarti*, a new black fly from the western United States (Diptera, Simuliidae). Bull. Brooklyn Ent. Soc. 53:1-6.

The new genera and species described in this volume appear in bold type in this index.

VOLUME XX

Date of Mailing Nos. 1-2 September 1, 1960
Date of Mailing Nos. 3-4 January 12, 1961